MEMORANDUM TO THE SCIENCE ADVISORY BOARD
ENVIRONMENTAL ECONOMICS ADVISORY COMMITTEE

ADDITIONAL EXPLICATION OF METHODS FOR MEASURING NON-USE VALUES: A CONTINGENT VALUATION STUDY OF GROUNDWATER CLEANUP

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1. Introduction

This memo is written in response to a number of remaining questions raised both by the Environmental Economics Advisory Committee (EEAC) as part of its review of the McClelland et al. report on the benefits of groundwater cleanup and by reviewers. We also include the view graphs used in our presentation to the committee as an Appendix. Prior to discussing specific theoretical and empirical questions raised by the EEAC, we provide some background information with respect to the purpose of the study under review.

The motivating question the groundwater study is designed to address is simply: Do any non-use benefits derive from corrective actions regarding groundwater contamination and if so, how large might they be? The contingent valuation study of the benefits of groundwater cleanup undertaken by the research team at the University of Colorado followed naturally from two prior contingent valuation studies. These previous studies were undertaken to examine methodological issues in using contingent valuation to measure the benefits from improving visibility in the Eastern United States. (Schulze, et al. March 1990; McClelland, et al. June 1991).

Results from these prior studies indicated, among other things, that 1) for a familiar commodity such as visibility, information had little effect on total values and 2) that embedding posed serious problems for disaggregating and interpreting respondent's stated values. Groundwater presented a more challenging commodity for valuation in that, as shown in pre-testing by Mitchell and Carson (1989), people know very little about groundwater and people reject an existence value scenario where groundwater would never be used i.e., they did not believe that clean groundwater would not be used ("... it is too difficult to overcome people's beliefs about future use by others to design a scenario that would only capture stewardship [existence] values.", p.85, Mitchell and Carson, 1989).

This scenario rejection problem severely limited the types of scenarios we could consider. For example, it would have been desirable to use a scenario in which groundwater was already contaminated and other surface water sources had been substituted. This would have allowed us to ask for existence values for cleanup of groundwater directly. However, the problem with. this scenario is that as soon as cleanup occurs, many respondents would assume that the water would be available for immediate use and include use values in their valuation. Again note that Mitchell and Carson were unable to convince pretest respondents that clean groundwater would not be used (".. many participants are unwilling to believe that there is no likelihood of future use in the relatively near future, despite specific assurances to the contrary.", p. 54, Mitchell and Carson, 1989). Given this problem, the ability of the CVM to estimate non-use values as a separate category from use values becomes difficult. However, groundwater does provide an excellent commodity to test the methodological limits of contingent valuation. Thus, our study should be viewed as exploratory in nature. Both the Office of Solid Waste and the Office of Policy, Planning and Evaluation recognized the experimental nature of the study and gave us complete intellectual freedom in its conduct.

The remainder of this memo discusses two issues, the definition of the commodity and the application of the study to the estimation of national benefits.

2. commodity **Definition**

The EEAC raised the issue of the definition of the commodity being valued by respondents in the national groundwater study. In response to USEPA's mission for the study, the benefits of primary interest are those deriving from complete groundwater cleanup with emphasis on non-use values. Complete groundwater cleanup can be viewed as a **hedonic** commodity which potentially consists of a vector of services including

1) reduced risk for present and future generations if the contaminated groundwater were potentially available for consumption
2) clean water for the current generation **(providing** use and **altruistic** values) if the contaminated groundwater is not believed to be available for current consumption
3) clean water for future generations (bequest values) if the contaminated groundwater is not believed to be available for future consumption
4) clean water even **if** such water is never used (existence values).

In practice the process of **disaggregating** such values has proven to be difficult in empirical analysis (See Section 3.3 pp. 33-49, of the report which discusses embedding). Further, serious theoretical questions have been raised concerning the possibility of double counting if altruistic and bequest values are naively included in a benefits assessment (see Chapter 2).

Given the charge from EPA, the first task was to examine the conditions under which non-use values are present and how they might be measured. First consider the difference between Expert benefits and Subjective benefits. Expert benefits can be defined as the benefits experts believe to exist. They are usually calculated as a value of a life times an expert assessment of risk reduction times the exposed population. This value obviously excludes at least some categories of non-use values and would limit consideration to the first category listed above for services provided by complete cleanup. Subjective benefits on the other hand are defined as the values potentially exposed people themselves and others place on environmental cleanup. These values will be based on perceived risks and will include non-use values if they are present. Clearly, however, to have subjective non-use values, consumers must know that a groundwater problem exists.

The distinction between Expert and Subjective benefits raises important theoretical questions in welfare economics. Use of expert assessments in public policy decision making may violate consumer sovereignty, but such judgments may be based on different (and possibly more complete) information. However, to obtain non-use values one must generally measure subjective values. In fact substantial subjective values have been shown to exist for LULU, NIMBY or BANANA[1] sites in a large number of studies using property values and/or contingent values in situations where expert risks and values are very small but where the public has become

[1]LULU = locally undesirable land use: NIMBY= not in rny backyard; BANANA= build absolutely nothing anywhere near anybody.

alarmed (See for example V.K. Smith and W.H. Desvousges, 'The Value of Avoiding a LULU: Hazardous Waste Disposal Sites" ReStat., 1986 and McClelland, Schulze and Hurd, 'The Effect of Risk Beliefs on Property Values: A Case Study of a Hazardous Waste Site," Risk Analysis, 1990).

Given the goal of measuring subjective values, a number of underlying factors had to be accounted for to develop a scenario for groundwater valuation. In real world contamination scenarios, offsite groundwater contamination of wells assures public awareness of a problem. Further, regardless of how small the expert assessment of risk may be, to our knowledge, public officials have never knowingly allowed contaminated water from a NIMBY site into a public water supply. This effectively rides out category (1) of services as described above.

Further in our own survey pre-testing and in real world situations, attempts at risk communication have been surprisingly ineffective. For example, in survey pre-t esting, risk information was given to respondents on a risk ladder which showed that the relative risk of drinking the contaminated water was extremely small. This information had no effect on 76% of subjects, raised values for 15% and lowered values for only 9% of the respondents (see Table 2 below). At the same time new research showed that the conventional wisdom in risk communication which suggested that a complex risk ladder was required proved to be false. Roth et al.. state that a comparison of two risks across (i.e. risk of x-rays compared to risk from drinking contaminated groundwater) fared much better than the previous literature had suggested (Roth, Morgan, Fischhoff, Lave and

[2] USEPA at one time attempted to have experts from the Center for Disease Control evaluate risks at Superfund sites and inform local residents tn person of the magnitude (very small) of those risks. These experts were in nearly all cases "run out of town on a rail", i.e., they were met with complete disbelief and hostility.

Bostrom, 1990). Given that the risk ladder appeared to raise rather than lower values, we decided to replace the risk ladder with a direct comparison between risk from medical x-rays and risk from drinking contaminated groundwater. This fortuitous research development considerably simplified the resulting final survey instrument.

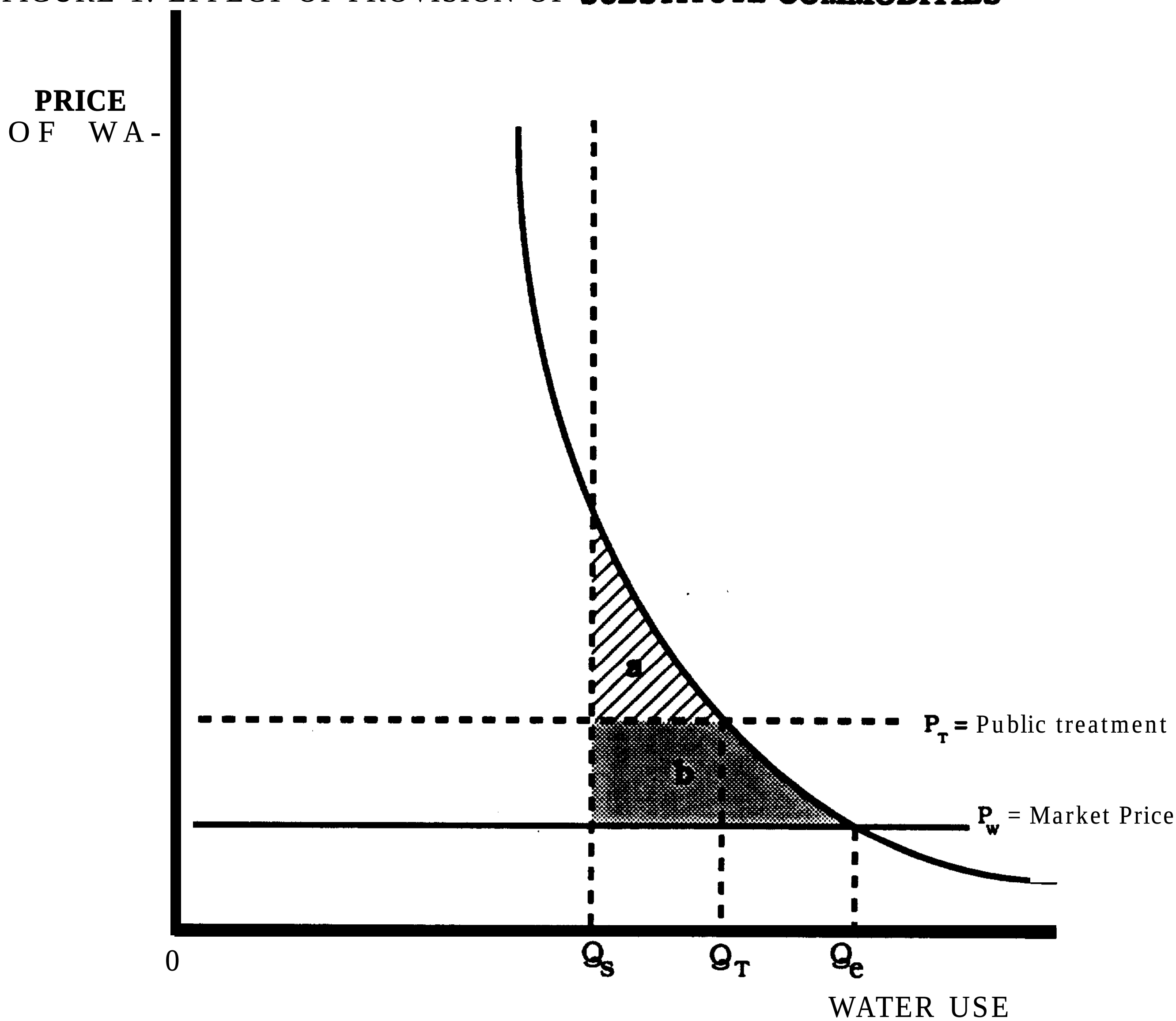
Thus, the scenario used in the groundwater survey describes the hypothetical case of offsite well contamination where public officials have eliminated the contaminated groundwater from the public water supply. This implies that values from this study fall In categories (2), (3) and (4) listed above <u>but</u> should most appropriately be applied only to sites with actual or potential offsite well contamination. In other words, it is highly likely that consumers living near a site with offsite well contamination will have heard about the site. This is a precondition which must be fulfilled for the existence of subjective non-use values such as existence value, but is likely to severely limit the number of sites to which the benefits should be applied.

The inclusion of other alternative options to complete cleanup has the following justification: as discussed by Fischhoff and Furby (1988), survey respondents are likely to use their own default assumptions with respect to a scenario if information is not provided in the survey instrument. In the case of groundwater contamination people may fear that no groundwater will be available for themselves or future generations without complete cleanup if this is the only option discussed, producing unrealistically high values. The groundwater survey thus specifies several default alternatives to eliminate the fear of “no water” without complete cleanup. From an economic as opposed to a psychological perspective these default alternatives enter the individual’s decision making process as substitutes to the complete cleanup program. These substitutes include (in the final design): 1) home treatment, 2) public treatment, and 3) containment. The no substitute alternative of water rationing (40% in the base scenario) is also included as a scenario for consideration. Since our hypothetical scenario involved a public water supply, and because of the high cost both In convenience and on a $/1000 gallon basis bottled water was not included as a substitute. This substitute would however be appropriate for the entirely different situation of contamination of private wells.

2A. A Theoretical and Empirical Analysis *of* Use Values Obtained in the Study

We begin a formal analysis by first only considering use values. Figure 1 shows a household demand curve for current use of water. At a price of P_w per thousand gallons, Q_e is the initial equilibrium quantity of water used. This corresponds to the situation presented respondents prior to discovering that the groundwater used in their public water supply has been contaminated by their local landfill. In Figure 1, Q_S represents the amount of water (60% of Q_e) still available from surface water sources, given that public officials take contaminated groundwater off line. If the only available alternative to complete cleanup of the groundwater is a shortage, then the willingness to pay for use value is the same as that to avoid the potential shortage. This is the sum of the shaded areas “a” and “b” shown in the figure (assuming that the price of water remains the same at P_w). If however, a substitute source of water from public treatment of the contaminated water is available at a price like P_T, the willingness to pay for use value for complete cleanup is reduced by the availability of the substitute to the shaded area “b” shown in Figure 1. It is important to note that the use value

FIGURE 1: EFFECT OF PROVISION OF **SUBSTITUTE COMMODITIES**



of complete cleanup (shaded area "b") is conditioned on both the availability of surface water Q_S (or conversely the magnitude of the potential shortage) <u>and</u> on the next best (cheapest) substitute available at price PT.

We can formalize the arguments made above as follows. Let

P = price of water

Q = **quantity** of water consumed by the household

P_w = price of untreated water

P_T = price of treated water ($P_T > P_W$)

Q_e = amount of water consumed at price P_W

Q_T = amount of water consumed at price P_T

Q_S = amount of surface water available to households given that contaminated of groundwater is not used

c = consumption of a composite commodity

Y^o = income

The analysis will continue to ignore non-use values for the moment so that the role of a substitute for complete cleanup, e.g. public treatment, can be evaluated in deriving use value for complete cleanup. Note that for simplicity we consider the case of a perfect substitute. The utility function $U(C,Q)$ thus depends only on the composite commodity, consumption C, and on water consumed Q. Since the survey values were generally less than half of one-percent of income, we further assume a constant marginal utility of consumption (money) so $\partial U/\partial C = U_c'$ = a constant. Thus, the utility function can be approximated as

$$(1) \quad U \approx U^o + U_c' \bullet (C - C^o) + W(Q)$$

where U^o is a constant, Co is the initial consumption level and W(Q) is the separable utility (as a result of a fixed marginal utility of consumption) derived from consuming water. Note that fixing U_c' does not imply that $\partial U/\partial Q = \partial W/\partial Q$ is fixed. To obtain the willingness to pay for complete cleanup take the utility of complete cleanup which provides Q_e but with a reduction in consumption equal to WTP (willingness to pay) for complete cleanup,

$$(2) \quad U(Y^o - p_w Q_e - -, \; Q_e),$$

and set it equal to the utility which obtains in the substitute situation where public treatment is the chosen second best alternative,

$$(3) \quad U(Y^o - p_W Q_T - (P_T - P_W) \text{ “ } (Q_T - Q_S), \; Q_T).$$

Note that in (3) the household pays a fixed marginal cost, $P_T - P_W$, for the portion of water which is treated, $Q_T - Q_S$, and pays the old price P_w for the surface water portton of water used, Q_S. If marginal costs of public treatment are constant (actually about $1.60 per thousand gallons for charcoal filtration)[3] and marginal costs of surface water provision are also constant, then this formulation provides the appropriate welfare measure. Setting (2) equal to (3) and using (1) yields

$$(4) \quad WTP \approx \left[\frac{W(Q_e)-W(Q_T)}{U_c} - p_W(Q_e - Q_T)\right] + [(p-r-W) \cdot (Q_T - Q_S)] \cdot$$

Where Q_T corresponds to the intersection of P_T with the demand curve in Figure 1, the first term in square brackets in (4) above corresponds to the

[3] We seriously considered providing this figure in the survey but this would have made it impossible to ask for a WTP for public treatment since the price of public treatment would have been known. Further we did not have available the costs of other alternatives which might be appropriate for inclusion in future research. Our public treatment alternative was similar to a real situation. The town of Commerce City near Denver, Colorado, is located next to the Rocky Mountain Arsenal. The town's wells were contaminated (at a very low risk, however) and the Army and USEPA were forced to construct a water treatment plant producing 100 million gallons of water per month of charcoal filtered groundwater. The plant cost about $12 million and operating costs are about 60¢ per 1000 gallons. Using a capital recovery factor of. 10 implies a total cost of treatment including capital and operating costs of $1 .60/ 1000 gallons. Commerce City gets an additional 23 million gallons per month from surface water sources. Thus, the town is about SO% dependent on groundwater. This solution satisfied the local residents who were outraged that their groundwater had been contaminated.

triangular shaded area to the right of Q_T (in the area marked b) and the second term corresponds to the remainder of the area marked b. to the left of * .

Obviously the survey design could have been simplified if only one substitute option, public treatment, was presented to respondents as the next best substitute. However, the next best substitute is complicated both by the varied nature of respondent preferences and by the additional consideration of non-use values. Looking at Table 1, public treatment is ranked second to complete cleanup by the “average” respondent. But, only 56% of respondents ranked complete cleanup highest, and only about one quarter of all respondents had complete cleanup ranked first and public treatment ranked second. In fact, many respondents who ranked complete cleanup first, ranked containment second (about 31 percent of the total sample). Thus, deletion of substitute cleanup options was not deemed feasible based on our pretest results which had revealed a similar preference pattern. Note also that many households ranked public treatment which does nothing to cleanup groundwater first, so existence values apparently did not matter greatly and their value given for complete cleanup would not

TABLE 1: RANKINGS OF **OPTIONS TO RESPOND TO** GROUNDWATER CONTAMINATION FROM VERSION D

RANKING	OPTION	MEAN LEVEL OF SATISFACTION
1	COMPLETE CLWP	4.35
2	PUBLIC TREATMENT	3.77
3	RATION - 10%	3.65
4	CONTAINMENT	3.40
5	HOME TREATMENT	2.89
6	RATION - 40%	2.61
7	RATION - 70%	2.35

(there is no statistical difference between the mean level of satisfaction for any of the options between respondents answering Version D and other versions - other versions did not rank 10% or 70% dependence on water) likely reflect an existence value. By thinking about an alternative substitute solution such as public treatment, respondents can think about whether or not existence values are important. Further justification for retaining a variety of substitutes can be obtained by looking at Table 2 which reports the results of our debriefing questionnaire used in pre-testing to determine what information was useful to respondents in constructing values.

The information and context presented in the survey had the effect of lowering the mean value for complete cleanup in our December 1990 pre-testing from $20.22 to $12.20. Table 2 helps answer the question, why did values fall? Looking at the "Lowered Value" rows in Table 2 shows that the largest self-reported impacts of information which served to lower value were associated with substitutes: the information on the water supply treatment option (public treatment, Q-55) caused 34°A of respondents to lower values, information on private options (home treatment, Q-53) caused 24% to lower values, and buy water (from another community Q-51) caused 20% to lower values[4]. In all of these cases the offsetting number of individuals who increased values consists of a much smaller group. Thus, we concluded that the most important information presented in the survey was information on substitute commodities since the evidence strongly suggests that the right hand tail of high values in the skewed distribution of bids was in great part eliminated by information on substitutes just as economic theory would predict i.e., respondents informed of substitutes reported area "b" rather than the sum of area "a" and "b" in Figure 1.

[4]The buy water option was replaced by a containment option in the final survey design because EPA was interested in obtaining a value for containment in situations where complete cleanup was infeasible. Containment received higher rankings and values than the "buy water" option did in pretesting.

TABLE 2: SELF-REPORTED EFFECTS OF CONTEXT DECEMBER 1990 **PRETEST**

Self-reported Effects of Context from December **1990 Pretest** (Summary of responses to **Q-47** through Q-56, Appendix B)

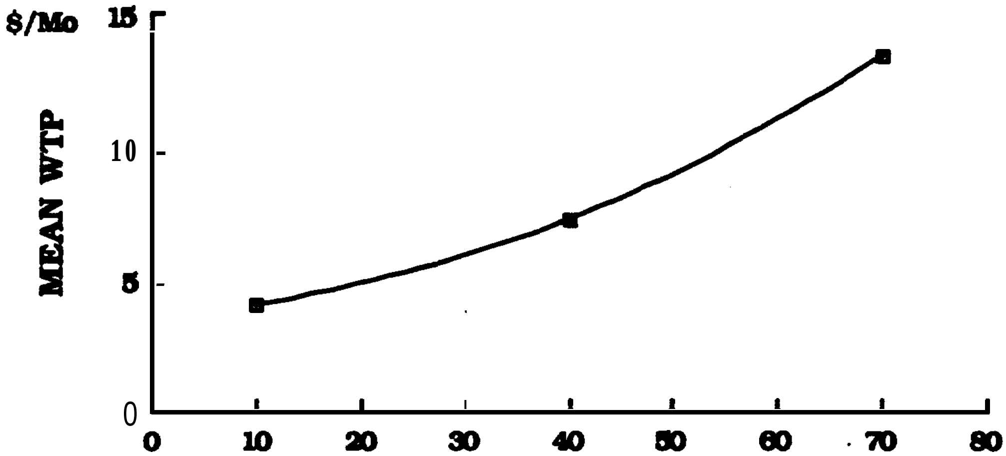
	Percentage				
Self- reported effect	**Q-47** **Pers.** **exp.**	**Q-48** Def. of **gwater.**	**Q-49** Speed of gwater.	**Q-50** Water bill	**Q-51** Buy water option
No effect	75%	82%	90%	77%	67%
Lowered value	0%	3%	8%	8%	20%
Raised value	25%	15%	2%	15%	13%

	Percentage				
Self- reported effect	**Q-52** Water cons.	**Q-53** Private options	**Q-54** **Dis-counting**	**Q-55** W. S. T. option	**Q-56** Risk **commun.**
No effect	72%	66%	79%	61%	76%
Lowered value	13%	24%	10.5%	34%	9%
Raised value	15%	11%	10.5%	5%	15%

The survey was thus designed so that if complete cleanup were not funded, respondents would likely assume a cheaper alternative would be funded (such as public treatment, or, in the **final** survey design, containment). However, respondents were left to implicitly guess at the price of these substitutes for the reasons noted in Footnote 3.

The small value obtained for a complete cleanup when a 70?? dependence on groundwater was used as the scenario also suggests that respondents were assuming substitute alternatives were available. Figure 2 shows values taken **from** Version D of the survey which asked for willingness to pay for complete groundwater cleanup as a function of the

FIGURE 2: PREDICTED WTP AS FUNCTION OF DEPENDENCE ON GROUNDWATER

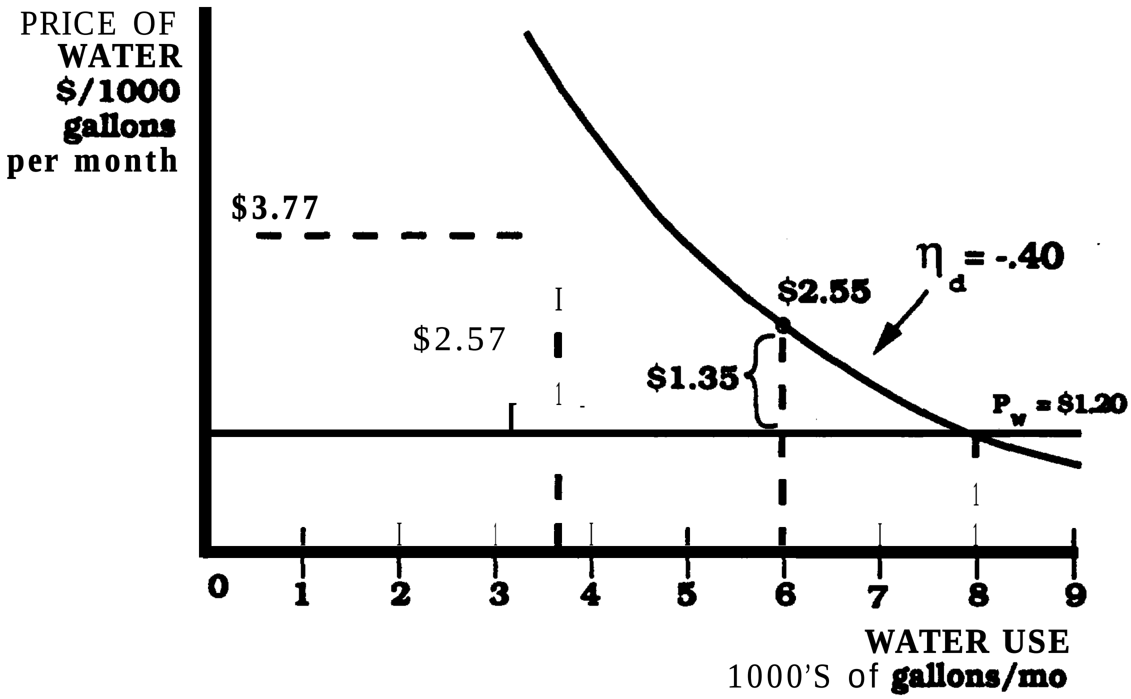


level of dependence on groundwater for domestic water supply (10%, 40%, and 70% dependence). Note that even as the dependence on groundwater increases to 70%, the total bid remains relatively small. Demand studies (cited below) suggest that this level of potential shortage should move into an almost totally inelastic region of the demand curve. Willingness to pay values should explode <u>unless</u> respondents assume substitutes for a water shortage are available.

From the information presented in Figure 2 we can derive an implied demand curve for water use. Figure 3 shows the water demand curve implied by Figure 2 where the marginal willingness to pay for water above its current price is taken as the slope of the bid function. The data presented in Figure 2 are converted to $/1000 gallons per month based on an average annual water usage in the United States of about 8000 gallons/month which we assume applies to our average respondent. The average U.S. price is about $1.20/ 1000 gallons. These estimates are taken from Michael

Nieswiadomy "Estimating Residential Water Demand" Water Resources Research, 1992. The midpoints of the water quantity changes along with the incremental marginal willingness to pay above the current average price of residential water are plotted in Figure 3. The first step down, from 8000 to 6000 gallons/mo. implies an arc elasticity of -.4. This estimated elasticity of water of -0.40 for moving from a 8000 to 6000 gallon per month dependence on surface water falls well within the range of water elasticities found in the empirical literature on water demands. Note that Nieswiadomy estimated demand elasticities as low as -0.11 and Howe (WRR, 1982) estimated demand elasticities as high as -0.57. Further, the more inelastic estimates are for winter demand and the less inelastic are found for

FIGURE 3: DERIVED WATER DEMAND CURVE AND ELASTICITIES



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[5] Figure 2 implies that households would on average bid an additional $1.35/1000 gallons of water (based on average water use) to avoid moving from a 10% to a 4096 "shortage" and $2.57/ 1000 gallons to avoid moving from a 40% to a 70% "shortage."

summer demand. The next step shown in Figure 3 from 6000 to 3600 gallons per month implies a very low total price for water of $3.77/1000 gallons. Based on existing demand studies we conclude that respondents seem to be limiting their marginal WTP by considering substitutes.

2B. A Theoretical and Empirical Look at Non-Use Values

Empirically very little is known about the nature of non-use values. In general, respondents to CV studies will attribute a large share of values to non-use categories if asked to split up their values (e.g., Greenley, Walsh and Young, 198 1) Altruistic and bequest values have been challenged theoretically and one empirical study (Madariaga and McConnell 1987) has shown that this challenge has at least some validity. Based on our own verbal protocols and pretest results which provide some indication as to the nature of preferences for non-use values, Chapter 2 of the report attempted to explore a number of possible theoretical models of non-use values. Given this situation, and given the severity of embedding problems (as documented in Chapter 3), we employed three separate approaches in the . study to attempt to partition total value into use and non-use components. Each method has obvious problems and advantages. In what follows we first consider theoretical issues relevant to measuring non-use values and then turn to psychological issues relating to how individuals think about non-use values.

<u>Theoretical Issues;</u>

To begin the discussion we construct a first order model which assumes separable utility both between use and non-use and between categories of non-use such as altruistic, bequest, and existence motives. Thus, we initially assume that utility can be written as

(5) $U(C,Q) + A + B + E$

where A is the altruistic utility derived from providing clean groundwater to the present generation (friends and neighbors) B is bequest utility derived from providing clean groundwater for future generations, and E is utility derived from knowledge that groundwater itself exists in an uncontaminated state independent of use. Following the theoretical analysis for use values provided above, assume that complete cleanup provides levels of non-use related utility A_C, B_C, and E_C while public treatment provides levels of non-use related utility A_T, B_T, and E_T. Then, to adjust the argument for inclusion of non-use values we only need to add 4, B_C and E_C to expression (2) of the preceding section which describes the utility of complete cleanup and AT, B_T and E_T to expression (3) which describes the utility of public treatment. To insure the legitimacy of including values derived from A and B we assume that these utilities derive solely from paternalistic altruism (See Chapter 2). Note that this is a very simplistic analysis since we do not explore either the nature of altruism or the functional dependence of A, B, and E on quantities of clean water available for use or in the ground over time. As shown in Chapter 3 these are in fact complex issues. Following the same procedure used in the preceding section and using equation (1), the willingness to pay for complete cleanup (WTPC) conditioned on a next best substitute of public treatment is

$$(6)\quad WTPC = WTP + \underset{(a)}{\frac{A_C - A_T}{U_C'}} + \underset{(b)}{\frac{B_C - B_T}{U_C'}} + \underset{(c)}{\frac{E_C - E_T}{U_C'}}$$

where WTP can now be interpreted as the separable willingness to pay for public treatment and is identical to the expression shown on the right hand side of equation (4) above. **Thus,** the availability of a substitute option lowers the use value **in** this more general case as it did **in the** case of use value alone. However, the term **WTP** implicitly now includes not only use value but also the <u>**cost**</u> of providing the joint non-use benefits which accrue from public treatment which are equal to $\frac{A_T}{U'_C} + \frac{B_T}{U'_C} + \frac{E_T}{U'_C}$. **These** benefits 'f providing non-use values for the public treatment option **are** correctly . **proxied** by their costs contained in the WTP term (i.e. see equation (4) which includes the term $P_T - P_W$) in valuing complete cleanup. Thus, the substitute option also serves to potentially reduce these values as well. Terms (a), (b), and (c) in equation (6) are, respectively the separable incremental willingness to pay for altruistic, bequest, and existence value as provided by complete cleanup over and above those provided by public treatment.

The question of **the** separability of non-use values which allows this very simple structure is, of course, a purely empirical question about which little is known and which is likely to be confounded with the embedding problems which are discussed at length in Chapter 3. Usually pure existence values (term c above) are assumed to be separable (Freeman 1992). This separability is assumed to make indirect market based valuation impossible. Thus, such values also leave no behavioral trail (see also Report to NOAA of the Panel on Contingent Valuation, January 1993). The separability of altruistic and bequest values has had even less discussion in the literature. We view equation (6) as a first order approximation only to begin to explore the issue of **identifying** component values.

The first of three methods employed in the study for attempting to partition values as shown in equation (6) is use of a scenario **difference.** In particular a **subsample** in the **survey** was asked both for the value of complete cleanup and for their value for **public** treatment. We then estimated non-use values by **subtracting** the **public** treatment value from the complete cleanup value which is the same as subtracting WTP from both sides of (6). Referring to equation (6) it is likely that E_T = O for public treatment since nothing is done about subsurface groundwater contamination so **WTPC-WTP** will contain a complete measure of existence value. It is likely that B_T = O since future generations (at least in the far future) will benefit little from a treatment plant constructed today compared to complete cleanup which insures clean water is **available** for **all** time. Finally it is likely that $A_C \approx A_T$ since both complete cleanup and treatment protect the current population. Thus, **WTPC-WTP** is likely to exclude altruistic benefits. This difference (under our assumptions that E_T = O, B_T = O and & = A_T) can be expressed as .

$$(7) \quad \mathrm{WTPC} - \mathrm{WTP} = \frac{Bc}{U'_c} + \frac{Ec}{U'_6}$$

Separability is not necessary for this approach to work. However, the resulting measure will likely exclude altruistic values.

The second approach was to ask respondents to split up their bid for complete cleanup into four categories. The obvious problem from (6) is that the WTP term incorporates the joint cost of providing& B_T and E_T as the appropriate **proxy** for benefits which is the cost of public treatment. However, under our assumption that E_T = O, B_T = O and AT = A_T, (6) **can** be rewritten as

$$(8) \quad WTPC = WTP + \frac{B_c}{U'_c} + \frac{E_c}{U'_c}$$

where as noted above **WTP** is **in** part a cost based measure of the value of providing $\frac{W}{U'_c}$ and $\frac{AT}{U'_c}$. This raises the question of how respondents will split up the **WTP** term. This is the standard allocation of joint cost problem which has no obvious solution. One hypothesis would be that **WTP** is allocated by respondents in proportion to the relative magnitudes of W/U'_c and A_c/U'_c. Note that $WTP \leq W/U'_c + A_c/U'_c$ since costs are less than benefits for use and altruistic values. Thus, we see that the presence of substitutes complicates the percent split approach even where separable utility is assumed. However, the percent split approach is most likely to be valid for the case of existence **values** where separability is most plausible and no other substitute (including containment since values were comparable to public treatment) was viewed as assuring clean groundwater independent of use.

The third approach was to reduce the dependence on groundwater from 40?? to a low level (1 O%) and extrapolate **WTPC** to a no dependence scenario. We felt we could not use a O% dependence scenario directly since this approach had been rejected by the Mitchell and Carson pretest respondents **(i.e.,** "someone, sometime will use the water no matter what the survey says"). Presumably a zero percent dependence sets & = A_T = O as well as **WTP** = O. Thus, (6) would now take the form

$$(9) \quad WTPC = \frac{B_c}{U'_c} + \frac{E_c}{U'_c}$$

providing a direct estimate of bequest and existence values. A problem with this approach in addition to its exclusion of altruistic values is that B_c may be conditional on surface water dependence.

Psychological Issues:

The discussion above details the theoretical assumptions and implications of value partitioning. This section is concerned with the question of whether individuals can actually partition the values in a meaningful way such that they can be stated in response to contingent valuation questions. This is a question of the psychological process of respondents' value construction using the information and context in the survey instrument. These psychological questions can be defined by two primary concerns: First, do people have enough information to be able to partition the values they are providing and, second, have people thought carefully enough about the issues presented to allow partitioning?

In pre-testing the survey instrument this process was investigated largely in terms of what information and context individuals used in value construction. In pre-testing, respondents overwhelmingly rejected a proposed fund for future use. The option offered did not fit individuals' psychological model of how the world works and thus many respondents simply refused to state a value for the program. The survey instrument provided alternative scenarios to educate respondents and to get them to think about future generations and about existence values that may obtain from the proposed cleanup scenario. The rankings of individuals for these options suggest that respondents were thinking about the varying aspects of the programs in a manner consistent with value construction based on the hedonic attributes different options provided.

AS Table 3 shows, the options including more attributes or services as listed on pages 2 and 3 are rated higher by respondents suggesting both that the survey provided enough information regarding the commodity being valued and that many individuals thought **carefully** about the issues.

TABLE 3: OPTION RATINGS RELATED TO BENEFIT COMPONENTS

OPTION *(MEAN* **RATING)**	OPTION BENEFITS
COMPLETE CLEANUP **(4.35)**	Respondent's Use (Use Value) Other's Use (Altruistic Value) Future Use (Bequest Value) Existence 'Value
CONTAINMENT **(3.45)**	Respondent's Use (Use Value) **Other's** Use (Altruistic Value) Future Use (Bequest Value) Some Existence Value less certain
PUBLIC TREATMENT (3.74)	Respondent's Use (Use Value) Other's Use (Altruistic Value)
HOME **TREATMENT** **(2.81)**	Respondent's Use (Use Value)

Table 3 indicates that individuals were implicitly able to distinguish the components of the value of complete groundwater cleanup in their preferences since they were able to rate the different options based on these components. The value partitioning question asked individuals to directly partition these values as a portion of total value. Some critics of this approach have argued that when faced with such a cognitive task that individuals will simply allocate an equal percent to each of the categories offered (i.e. 2596 into each of four categories offered totaling to 100?A).

Table 4 shows the component allocation for a random **subsample** from the survey respondents (every 50th respondent in the econometric data set). Considerable differences in partitioning of values are shown for

TABLE 4: PERCENT COMPONENT ALLOCATION OF TOTAL WTP FOR COMPLETE GROUNDWATER CLEANUP (RANDOM SUBSAMPLE)

OBS	USE	ALTRUIST	BEQUEST	EXISTENCE
50	o	0	0	100
100	0	0	0	100
150	25	25	25	25
200	33	33	34	0
250	20	20	30	30
300	0	50	50	0
350	30	30	30	10
400	50	20	20	10
450	0	100	0	0
500	60	20	20	0
550	50	30	10	10
600	25	25	25	25
650	90	4	4	2
700	50	20	25	5
750	25	25	25	25
800	25	25	50	0
850	25	25	25	25
900	50	0	50	0
950	100	0	0	0
1000	33	33	34	0
1050	30	30	30	10
1100	40	30	30	0
1150	25	25	25	25
1200	0	0	100	0
1250	30	30	30	10
1300	o	0	0	100
1350	30	10	10	50
1400	33	33	34	0
1450	25	25	25	25
1500	25	25	25	25
1550	5s	22	3	17
1600	70	5	20	5
1650	25	25	25	25
1700	o	0	0	100
1750	0	0	0	100
1s00	50	20	20	10
1850	20	20	30	30
1900	60	30	5	5
1950	33	33	34	0
2000	0	0	0	100

different individuals. For observations 50 and 100, for example, all value is allocated to existence. For individual 950 all value is allocated to current use. Others, such as 200 and 1000, allocate evenly between use, altruistic and bequest values (all consumptive options) and place a zero value on non-consumptive existence value. The table also shows that roughly one out of five individuals could be claimed to be simply dividing 100% by the four categories offered. The majority of the respondents do however seem to be making a conscious allocation between the four components This type of partitioning may only provide only a very rough indication of the relative importance of the components of value. However, if serious doubts exist as to the validity of certain components (such as altruistic and bequest values which may represent double counting), value partitioning allows such values to be discarded to obtain a conservative estimate of total value. Note that the component split questions followed the total question and can be viewed as debriefing questions which simply provide additional information[6].

Further Evidence on Non-Use Values

Previous CV studies of groundwater values from private wells have almost always assumed that non-use values were incorporated in the stated values. For example Edwards (1988) states:

> "Even households with a zero probability of future demand for groundwater on Cape Cod have positive option prices. This benefit is attributable exclusively to the bequest motivation." (Edwards, p. 484),
> as well as.
>
> "A second surprising result is the small size of option value relative to option price (1-2% or less)" (Edwards, p. 486),
> and finally,
>
> "A third interesting result is the strong influence of bequest motives on total willingness-to-pay. Equity issues not withstanding individuals appear to be willing to pay substantial amounts of money annually to protect groundwater for use by future generations." (Edwards, p. 486).

[6]The issue of reading ahead was raised by the committee. Having observed hundreds of self-administered pretests where reading ahead was allowed, we can state that this "problem" is very rare. Occasionally, however, a test respondent will flip ahead to see how much la left to do.

Poe and Bishop in their recent study of contamination of private wells reach similar conclusions, as do most other researchers. A priori, since our study deals with contamination of public rather than private wells, it seems even more likely that our study would include non-use values.

To demonstrate that individuals have non-use values for groundwater cleanup remains an empirical issue for our study. As described above, the groundwater survey included variations of the survey instrument to provide three alternate approaches for estimating non-use values. (1) Scenario Difference Approach: Version C asked for respondent's value for a public treatment option which would only clean up water as used. The public treatment option mostly captures use value and clearly excludes existence value so the difference between the value for total cleanup and public treatment approximates (but likely underestimates) non-use values. (2) Component Allocation Approach: All versions of the survey asked for the value of complete groundwater cleanup and how respondents' values were allocated between categories of use and non-use values. (3) Extrapolation Approach: Version D of the survey asked respondents how much they would value complete cleanup if they depended on groundwater for 10??, 40%, or 70% of their total water supply. By modeling each individual's values as a quadratic (or linear) function of the percent of water shortfall, the intercept predicts the bid when there is no dependency on groundwater. The intercept thus estimates non-use value for groundwater cleanup. The mean estimates for non-use values (bequest and existence values combined) are $2.81, $3.49 and $3.54 (quadratic, linear is $2.89) per household/per month for the scenario difference, percent splits and extrapolation approaches respectively.

Additional support for the contention that non-use values exist and were measured for groundwater can be found in the pre-testing of the survey instrument. During this pre-testing, verbal protocols and retrospective reports were used to examine individuals' cognitive processes while completing the survey instrument. These verbal protocols and retrospective reports provide direct evidence that individuals hold non-use values for groundwater:

> ". ..of course the immediate concern would be for me, my family and future generations (which includes my family). What other things would I be concerned about... if it wasn't for you, your family and future generations."

> "I think that they are probably going to have to have places to grow food where they know it will be safe. And places with water that they know will be safe. I don't think it is going to be anything like it is today"

> ".. .we probably ruined the water so we should do something to fix it. I was thinking we should do something for our kids. I have a kid."

> "Contamination problems, the main thing I was concerned with is the fact that this solves problems permanently as long as no more contaminants get into the ground. With people paying a large amount of money they are going to be after them to make sure the water stays clean instead of treating it as you use and keep polluting it??? . . .Mostly in terms of the future so you know you are not procrastinating the situation."

> "I feel like its important that something is done, sometime somebody is going to have to pay for it. It may as well be this generation because I think people are more than/ they should be willing to have clean water."

> "I don't trust the people other than the people involved at this time will have the same level of commitment to keeping groundwater clean and pure..."

> "... you never know if something is set up if it will actually happen and you don't know if people will use the money for what it was meant for."

These individuals display paternalistic or non-paternalistic altruism in deriving their values for future generations in addition to a concern simply that the groundwater be cleaned up. In contrast, some individuals display no particular concern for future generations:

"I am not one to think long term, unfortunately"

As Table 4 showed above, individuals are different and thus allocate their values differently between use and non-use values. As these quotes from the verbal protocols and retrospective reports show, these value allocations are based on different concerns for future generations and the environment. These concerns are direct evidence of the presence of non-use values for groundwater cleanup.

Finally a fourth approach for empirically estimating non-use values was derived from post-testing of the survey instrument in Denver during the Spring of 1993. The same survey was used but with additional questions added to deal with the question of market size for applying the household benefits and timing issues of the completion of groundwater cleanup. Following the valuation questions (which remained identical to those in the mail survey[7]) individuals were asked how long they had assumed groundwater cleanup would take. Following this, individuals were asked how much their value would change if the cleanup was not completed until 10, 30 or 100 years in the future.

[7]For the individuals answering Version A of the Denver post-test (where monthly WTP for groundwater cleanup were elicited) the geometric mean monthly WTP was \$7.32 (n = 36). We did not perform regression analysis (or Box-Cox transformation regression) on the post-test due to the sample size. The geometric mean 1s the anti-log of the mean log(WTP). This would be the effect of a Box-Cox transformation with a transformation coefficient of zero. This value of \$7.32 can be compared to the \$7.01 predicted WTP from the regression of the national mail sample.

As Table 5 shows the mean expected time to cleanup was 7.77 years. The willingness to pay for cleanup fell as the time to completion of cleanup was extended indefinitely into the future as would be expected.

TABLE 5: TEMPORAL ASPECTS OF CLEANUP VALUATION

	MEAN (STD DEV) n
'EXPECTED YEARS TO COMPLETION OF CLEANUP	7.77 years (5.40) 48
PERCENT OF BASE WTP IF CLEANUP COMPLETED IN TEN YEARS	82.03% (33.50) 69
PERCENT OF BASE WTP IF CLEANUP COMPLETED IN THIRTY YEARS	55.36% (40,58) 69
PERCENT OF EASE WTP IF CLEANUP COMPLETED IN ONE HUNDRED YEARS	36.30% (39.94) 69

Figure 4 displays the relation between WTP and time to completion. As cleanup is delayed beyond thirty years, the function flattens out at a positive level and <u>does not</u> approach zero which it would if individuals were simply exponentially discounting use values over time.

From this graph it appears that individuals are discounting some portion of the total value and that after approximately thirty years the value remains relatively stable. It is reasonable to assume that individuals will perceive a declining use value as the time to completion is drawn out but that if bequest and existence value are based on very long term considerations or on moral considerations these values will not depreciate to zero as the time to completion is delayed. The positive asymptotic value supported by the relatively horizontal portion of the graph can be considered a non-use portion of the total value (possibly consisting of bequest and existence values).

FIGURE 4:

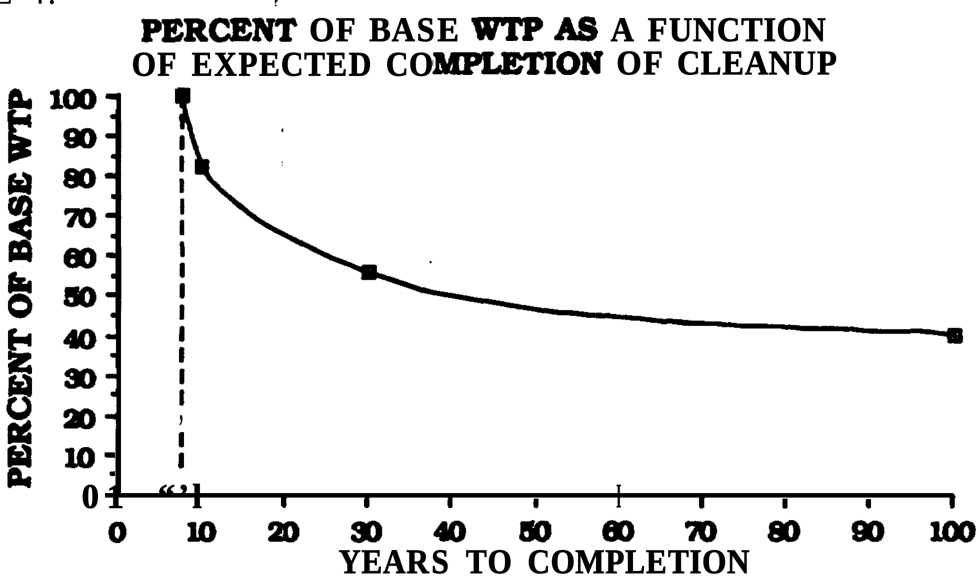

Table 6 indicates the implicit rates of discount the data imply based on the total stated value. The rate of discount after thirty years is close to zero (0.60?! per year).

TABLE 6: IMPLICIT RATES OF TIME PREFERENCE

Between 7.77 yrs and 10 yrs	8.89%/yr.
Between 10 yrs and 30 yrs	1.97%/yr.
Between 30 yrs and 100 yrs	0.60%/yr.

Since virtually all respondents will be dead within the next hundred years it is reasonable to assume that any values for cleaning up groundwater in one hundred years are not use values (either for oneself or for others now alive which we label altruistic values). The mean percent allocated to non-use in the national groundwater survey was 44.20A. In post-testing, the mean percent of total WTP individuals stated they are willing to pay for cleanup with completion in one hundred years is 36.3% of total value. If there is some loss of bequest or existence value during the cleanup delay then this approach would underestimate non-use values to some degree. For the post-test subjects there was not a statistically significant difference between the non-use WTP using the component allocation approach or the WTP for complete cleanup with a one hundred year completion date[8].

Pre-Testing of the Commodity

Our pre-testing of the commodity began with the design of a lengthy pre-test survey instrument containing a variety of test approaches for attempting to partition non-use from use values. In designing this pretest instrument we carefully evaluated the prior study by Mitchell and Carson (1989). This study only went so far as to conduct focus groups in which subjects were exposed to information on ground. water and hypothetical groundwater scenarios. No preliminary survey appears to have been pre-tested. Rather, based on general reactions to information and scenarios in the focus group sessions, a first draft survey was prepared for possible later pre-testing. Much valuable information was obtained from the focus groups. Our own detailed reading of the transcripts suggested two conclusions: (1) most participants knew little about the scientific aspects of groundwater and (2) respondents strongly rejected scenarios in which groundwater would supposedly never be used. Respondents plausibly rejected the notion that

8For Version A (monthly W'I'P): t = -1.65, p = .11, n = 34: for Version B (lump sum WTP): t= 1.04, p = .31, n = 27 clean groundwater would never, ever be used by anyone, anytime in spite of numerous guarantees made now. Mitchell and Carson came to the same conclusions. However. surprisingly, in their draft survey, they still attempted to construct a scenario in which groundwater would never be used, providing assurances that government would deny access to groundwater below a newly proposed landfill . Note that in our own pre-testing respondents uniformly rejected government assurances of future action, e.g., "If it is not done now we doubt it will ever happen." We found this scenario to be unlikely to succeed based on Mitchell and Carson's own focus groups and it should be noted that they expressed reservations themselves. Further, Mitchell and Carson chose not to continue the study. We did view their scenario as a backup strategy in case other approaches failed.

Thus, since respondents rejected a scenario which would allow direct estimation of non-use values, we were forced to attempt to partition values. Note that we defined a specified believable current use-value so that respondents would not substitute their own uncontrolled assumptions about use as we believe they would have in the Mitchell-Carson scenario. Only two approaches are available for partitioning values: (1) asking respondents to directly partition values and (2) use of scenario differences. Both methods have a long history in contingent valuation studies dating back to the late 1970s (reported in studies such as Brookshire et al. 1979, Greenley, Walsh and Young, 1982, Tolley *et al.*. 1985, and Mitchell and Carson, 1987). We should also note that both the extrapolation approach and the temporal delay approaches described above are variants of the scenario difference approach. Thus, a major goal in pre-testing was to solve three potential problems with the scenario differences approach.

First, respondents may not understand the differences in scenarios well enough to provide different values. Thus, pre-testing should be able to show demonstrable value differences.

Second, one hypothesis explaining the embedding problem which could confound the scenario difference approach is the warm glow phenomenon (Andreoni, 1989). If the first scenario gets an extra warm glow value attached to it and the second does not, bias could result. For example two questions might ask for the value of partial environmental cleanup and then for the value of complete cleanup. The difference, then, should value incremental aspects of cleanup of interest to researchers. However the difference will be reduced if the first bid incorporates the pure separable satisfaction of contributing to a good cause (warm glow) while the second does not. Thus, we have specifically attempted to remove warm glow values with a disembedding question[9].

Third, scenario rejection often occurs when multiple scenarios are presented. If some people prefer scenario A to B, they will bid for A but then feel no obligation to bid for B, even if it has some value to them as an alternative. A referendum approach can exacerbate this phenomenon in that people are unlikely to be willing to vote for a less preferred alternative.

To attempt to address these and other issues we began pre-testing with a first phase which obtained 10 verbal protocols which recorded the detailed thoughts of respondents as they filled out two versions of the pre-test instrument. To our knowledge this was the first application of verbal protocols to the design of a CV instrument. The transcripts from these were only briefly extracted in the report because they are comparable in

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[9] Mitchell and Carson in their draft groundwater survey also include a disembedding question of slightly different design.

length to the report itself. Verbal protocols have proven to be much more revealing of the detailed thought processes of respondents than focus groups. Thus, the verbal protocols gave us substantial insights into the detailed thought processes of respondents, processes which are masked in group settings. For example, they showed a strong tendency by respondents to override assumptions made in the design of the survey instrument with their own beliefs if those beliefs contradicted those implicit in the survey instrument. These beliefs about the way the world works have been termed mental models by psychologists (see for example, Bostrom, Fischhoff and Morgan, 1992). Subsequently, the survey was designed to avoid contradictions between survey design assumptions and respondent's mental models (e.g., government can't be trusted).

We further found that the "commodity" as economists would term it was, of course, nothing of the sort in the minds of respondents. Rather, they viewed the survey as presenting a problem for which a number of alternative solutions were presented. Many economists might view contaminated groundwater as a small reduction in the total quantity of all clean groundwater. In contrast, residents near a NIMBY site view contaminated groundwater as a separable commodity or problem in and of itself which directly provides negative utility. Overwhelming psychological evidence supports this latter view (see for example McClelland, Schulze and Hurd, 1990 and Bostrom, et al. 1992). In this sense the final version of the groundwater survey closely follows the kind of process people and real communities follow for solving problems. First, citizens find out about the problem and then alternative solutions are evaluated, compared and ranked. In this sense the original version of the survey (with a series of referenda on different solutions used to explore alternative valuation strategies) was viewed as unrealistic by respondents. The sequence of referenda created a scenario rejection problem which was clearly demonstrated in the second phase of pre-testing which employed self-administered surveys for 80 respondents. We discovered that when a respondent had voted yes on a particular solution, and when a following alternative was lower ranked (but quite likely still "acceptable") there was a strong tendency to vote "no" on the lower ranked option (scenario reject) even though the respondent still had a positive value. This caused us to drop the referendum format inasmuch as we wanted to obtain multiple values from each individual to allow use of the scenario difference approach.

Thus, in the third phase (117 respondents) we tested a format which had respondents consider all alternative solutions (by rating each of them) before valuing complete cleanup. This design worked very well because it now conformed to what respondents viewed as a natural cognitive flow (1) present problem, (2) consider alternative solutions for the problem, (3) value one solution which might be "chosen" by the community, and (4) value an alternative solution in case the initial "choice" is infeasible. However, dropping the referendum format in and of itself was not sufficient to entirely eliminate scenario rejection for the second valued scenario. The problem demonstrated in phases I and II of pre-testing was an inherent reluctance to put a value on a less valued commodity. To explain this psychologically, imagine that a consumer prefers a Lexus to a Volkswagen. A Volkswagen sales person then asks "What would you pay for this Volkswagen." A natural response would be for the consumer to say "nothing," i.e., reject the scenario. Another way of asking this question which helps greatly to overcome scenario rejection is to ask for a relative value, i.e., "thinking about the Lexus I know you want, how much of what you would pay for the Lexus would you pay for the Volkswagen." This relative comparison focuses the respondent immediately on the features of the Volkswagen relative to the features of the Lexus and on missing attributes of the Volkswagen. The value of the Lexus forms an anchor from which the respondent can adjust his or her value down based on missing features or characteristics. A large literature exists in psychology on anchoring and adjustment, much of it addressed to cognitive error introduced by respondent use of inappropriate anchors (see for example Tversky and Kahneman, 1974, Carlson, 1990, Northcraft and Neal, 1987, and Kahneman, 1992). In our survey design, however, we deliberately established an appropriate anchor (complete cleanup) as the basis for adjustment. The pre-testing in phase III of this approach was successful beyond our hopes in that we found little evidence of scenario rejection in debriefing subjects and had a very high response rate for obtaining relative values.

It should be explained that in both the second and third phases of pre-testing with self-administered surveys, respondents were given a debriefing survey, essentially a survey about the survey, which produced information such as that presented in Table 2 above, which convinced us of the importance of substitute options. Note that Table 2 strongly suggests that the most important information in the NIMBY context of our survey was information about multiple substitutes, not information about risk or the scientific aspects of groundwater. The 197 debriefing surveys provided guidance on design issues both from quantitative information as well as from qualitative information taken from open-ended questions. In essence, our survey was presented for comment to 207 reviewers (including the 10 individuals who provided verbal protocols) whose opinions we took very seriously in designing the survey instrument. It is our view that major problems in past CV studies have resulted from the failure to design instruments which were understandable to and accepted by respondents as opposed to experts in survey design. Since experts (such as ourselves) often have expectations which are inconsistent with the actual views of respondents, we consider the process described above to be indispensable in developing a defensible contingent valuation instrument. To our knowledge this type of cognitive design process has never before been implemented in a CV study. We took a psychological approach to attempt to overcome what have appeared to be intractable problems in obtaining component values (see for example, Tolley, et al., 1985, who found large order effects which are attributable in our view to warm glow and scenario rejection problems).

Further, it is our view that component values must be identified if problems such as the potential double counting of altruistic values are ever to be addressed. For example, the NOAA sponsored Alaska study, by only obtaining an option price, is open to the charge of double counting altruistic and bequest values as well as the inclusion of warm glow values. The approach we have attempted at least allows for the possibility of discarding such values to obtain a lower bound estimate.

Finally, the only possible test of the reliability of the measurement of non-use values is internal consistency between different ways of obtaining non-use values within a CV study. Since no other approach has yet to be proven, internal consistency is the only game in town. Thus, we employed four methods in our survey designs (percent splits, a scenario difference between complete cleanup and public treatment, extrapolating dependence on groundwater to zero, and temporal delay of cleanup) to attempt to provide internal cross validation.

A Comparison Of Recommendations Of The NOAA Panel On Contingent Valuation With Procedures Used In The Groundwater Study.

Motivated by controversy over the Exxon Valdez damage assessment, NOAA recently commissioned a “Panel on Contingent Valuation” which concluded that contingent valuation provides a reliable measure of non-use values (passive use in their terminology) as long as a lengthy list of specific criteria are satisfied. Those most relevant to our study include:

(1) Use of probability sampling
(2) Minimization of non-response
(3) Use of face-to-face interviews or telephone rather than mail-Surveys
(4) Careful pre-testing of the questionnaire
(5) Conservative design
(6) Use of Willingness to Pay as opposed to Willingness to Accept measures of value
(7) Use of a referendum format for eliciting values
(8) Accurate description of the program or policy
(9) Photographs should be pre-tested
(1o) Reminders of substitute commodities should be included
(11) “A “No-answer” should be included for valuation questions
(12) Follow-up questions should be provided to valuation questions
(13) Checks of understanding and perceptions of the survey by respondents should be made
(14) Respondents should be reminded of alternative expenditure possibilities
(15) Values derived from a warm glow or dislike of big-business should be deflected.

(16) The timing cf remediation should be clear to respondents

In particular the panel argued that they would view as unreliable a study which

- had a high non-response rate
- showed inadequate responsiveness to the scope of the insult
- showed a lack of task understanding by respondents
- had many respondents who did not believe the restoration scenario
- contained votes on the referendum question not explained by economic value motives

Given the highly specific nature of their detailed list of recommendations for survey design and implementation, the NOAA panel qualified their recommendations as follows: "We think it is fair to describe such information as reliable by the standards that seem to be implicit in similar contexts, like market analysis for new and innovative products and the assessment of other damages normally allowed in court proceedings. As in all such cases, the more closely the guidelines are followed, the more reliable the result will be. It is not necessary, however, that every single injunction be completely obeyed; inferences accepted in other contexts are not perfect either." (tit.p.42)

Since our groundwater study was designed and implemented much prior to the release of the NOAA panel report on Jan. 1 1th, 1993, and since several of the panel's recommendations are controversial, no CV study accomplished to date including the one reported here complies fully with all of their recommendations. While our study followed the vast majority of the recommendations, it is useful to point out specific differences between our study and the panels' recommendations. These relate to recommendations

(3), (7) and (11) as listed above. We know of no literature which provides quantitative statistical support for recommendation (11), the provision of a "no answer" option for respondents--arguments can be made on both sides. But without quantification, this point remains nothing more than speculation by the panel. Our speculation differs from the panel, but we feel that this issue merits little attention. More evidence does exist on points (3) and (7), although that evidence suggests more of a healthy debate than overwhelming support for a particular position.

Point (3) argues that in person or telephone surveys are inherently superior to mail surveys Since the only member on the panel with extensive survey data collection expertise was Howard Schuman, this recommendation likely represents the position of one individual who is well known for taking a polar view on an admittedly controversial subject. Since USEPA has extensively employed mail surveys in their valuation research, they requested a specific evaluation of this recommendation from Dr. Donald Dillman, Professor of Sociology at Washington State University, who is also now Chief Scientist of the U.S. Census. His response has been circulated to the committee and speaks for itself. We feel that further research on the issue of mail versus telephone versus in-person interviews is warranted. Our own view is that all methods can provide useful information if carefully implemented.

The other major difference between the groundwater study and the NOAA panels recommendations relates to point (7), use of a referendum format to obtain values. Prior to the panels' report, the most commonly used argument in favor of the referendum format was that policy makers would find the approach appealing. The primary objection was that many people don't vote, and would find the referendum notion difficult, having never experienced one. Natural resource damages accrue to non-voters as well as voters. The panel's recommendation appears, again, to be based on the fact that their main focus was on the NOAA damage study rather than on the published, refereed, literature which suggests that the referendum approach produces larger values than those obtained by traditional open ended or payment card valuation questions (see, for example Seller, Stoll, Chavas, 1985 and Schuzle, McClelland, et. al. 1989). Further, it has been shown in the experimental literature that the iterative hypothetical bidding process (used in the NOAA sponsored study by Mitchell and Carson) produces bids higher than those from an actual incentive compatible auction using real transactions (Coursey, Schulze, Hovis, 1987). This study showed that a direct question asking for maximum hypothetical willingness to pay was an accurate predictor of real willingness to pay. The payment card approach was chosen both because it produces conservative values and because it reduces scenario rejection as noted above. The context for our valuation question was precisely patterned after the well known Smith public good auction which has been shown to be incentive compatible both in the laboratory and in practice (public television uses the Smith auction to collect funds from local stations to support national programming such as McNeil Lehrer). The key feature is that money is returned if the public good is not funded.

3. Issues in the Use of the Benefit Estimates

The question arises as to how the benefit estimates from the groundwater survey can be used for determining benefits from groundwater cleanup for the nation. Specifically the question arises as to the utilization of the estimates for determining the national benefits from remedial actions with respect to contaminated groundwater under RCRA. Prior to attempting to examine the potential for aggregating benefit estimates from the groundwater survey we need to address some substantive issues not fully explicated in the McClelland et al. report. These include: 1) non-response 'bias, 2) sampling bias and 3) the question of "extent of market" or community size to which these individual benefit estimates should be applied.

3A. Treatment *of* Non-Respondents

The mean non-use value of $2.81 to $3.54 derived in Table 7.21 (p. 193) using three independent approaches obtain for those individuals in the regression sample: 1983 individuals. This group comprises a subsample of the original sample of 4533 individuals (see Table 6.2, p. 143). For purposes of applying these mean non-use benefit estimates we need to determine if the "non-regression sample" population has different values and if so how to treat these for aggregating population benefits. As illustrated in Table 6.4 (p. 146) there is evidence that those individuals who answered fewer questions in the groundwater survey (and thus self-selected out of the regression sample by item non-response) had lower willingness to pay values than those in the regression sample. These individuals stated a positive mean raw willingness to pay amount equal to roughly one half of the mean raw willingness to pay for those in the regression sample. A reasonable treatment of non-respondents would thus be to consider an upper bound approach in which non-respondents have a WTP equal to one half that of respondents and a lower bound approach which would be to assume that non-respondents have a zero value.

A second way of examining the issue of non-response bias asks whether individuals who do not respond have lower values. *A priori* it might be expected that individuals with lower values do not respond at all to the survey or, if they do, may delay their response until they have been "prodded" sufficiently by follow-up postcards and additional reminders. The results from the groundwater survey are actually counter-intuitive to this supposition. Table 7 presents the respondents mean willingness to pay as a function of how long it took for individuals to return the survey instrument after the first mailing.

TABLE 7: MEAN REDUCED WTP AS A FUNCTION OF TIME TO RETURN

RESPONSE DATE	MEAN REDUCED WTP (STD DEV) n
EARLY Oct. 31- Nov. 15	**11.42** (25.79) 1204
MIDDLE Nov. 16- Dec. 8	11.81 (26.29) 906
LATE Dec. 12- Jan. 7	14.85 (41.29) 73

The surveys were date stamped upon receipt. By matching date of receipt with mean reduced willingness to pay we are able to test for any change in mean WTP as the length of time to return increases. As can be seen from Table 6 the mean WTP appears to increase over time. This essentially rejects the notion that individuals with less interest or concern, and thus less willingness to pay, for the commodity will take longer to respond. The increase in mean WTP is not statistically significant however (F = 0.58, df = 2,180, n.s.). The variance in bidding does increase dramatically in the last group. This result suggests that our recommendation in the report that non-respondents should be assumed to have a zero value is likely to underestimate values.

3B. Sample Bias

All known methods of **survey** data collection produce sample bias. Unfortunately, the best approach for reducing sampling bias is the use of personal interviewers. This led **Schuman** to argue against the use of mail surveys for contingent valuation in his contribution to the evaluation of the contingent valuation method by a panel commissioned by the National Oceanic and Atmospheric Administration (**NOAA,** 1993). However, use of a sample-based approach which relies on costly personal interviews would severely limit the use of CV and further prohibit benefit transfers in many **settings**[10]. The sample-based approach involves obtaining as complete and unbiased a sample as possible for use in computing a mean value for the benefit assessment.

In contrast to the sample-based approach, a model-based approach, which uses econometric modeling to estimate a benefit function can be cost effective when applied to many situations. In this approach the admittedly biased sample of, for example. a mail **survey** is used to estimate a model of household willingness to pay, and relatively unbiased census tract data is used to predict benefits using the estimated model. Thus, in applying a

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[10]**Boyle** and Bergstrom (1992) **describe** benefit transfers **as** "the transfer of existing estimates of non-market values to a new study, which is **different** from the study for which the values were originally estimated... **[T]his is** simply the application of secondary data to a new policy issue." The transfer of values to new scenarios has received increasing attention particularly in situations where financial and time limitations preclude the individual site specific studies. Issues in benefit **transfers** related to the topic of water quality benefits was recently examined **in** a series of articles (Smith 1992, **Desvousges** et al. 1992, **Brookshire** and **Neill** 1992. Boyle and Bergstrom 1992, Loomis 1992, Atkinson et al. 1992). Some of the topics that were examined included regression analysis. **obtaining** and **analyzing** data, and the evaluation of policy changes that occur from the original study site to the site where the benefit **transfer** has occurred.

model-based approach, the investigator can correct for biases such as the tendency to obtain more responses from older, wealthier respondents. Obviously this procedure raises a number of statistical questions and requires a number of assumptions to be valid.

An ongoing statistical debate has, thus, arisen concerning sample-based versus model-based approaches (see Smith, 1983, Sarnadal, 1978, and Hansen et al., 1983) Unfortunately. Schuman did not consider model based approaches in his evaluation of the CVM. Given the significant differences in the costs of the two approaches, there are substantial ‘ potential benefits associated with research that can further justify the use of model-based methods. The model-based approach we recommended for application of our study was relatively unsophisticated and much more could be done in future research.

3C. Extent *of Market*

Once a function predicting household values has been estimated using a model-based approach, the question arises as to the relevant market area over which to apply the model. Given that the groundwater survey asked individuals for their willingness to pay for groundwater cleanup for their community, the appropriate market is the individual’s community. To support this contention one must first show that individuals have little or no value for groundwater cleanup in communities other than their own.

As discussed in the groundwater report, Versions B of the survey pursued the question of how much individuals are willing to pay for groundwater cleanup in other communities. As would be expected individuals valued local cleanup vastly higher than groundwater cleanup outside of their community. Mean non-use values for national groundwater cleanup were less than $1.00 per household with a modal value of zero. Given our analysis of skewed error in hypothetical values we conclude that national non-use values are not significantly different from zero.

This leaves the question of appropriate community size. The individual's concept of community size is an empirical issue which we examined in post-testing of the groundwater survey in March of 1993. Using the national mail groundwater instrument, we modified the survey following the initial valuation question to include questions about the community size respondents assumed in their answers. Figure 5 shows the distribution of respondent's concept of community size related to the local political unit. Based on this research we concluded that the appropriate market is the smallest local political unit, such as a town or city.

FIGURE 5: COMMUNITY SIZE **COMPARED TO POLITICAL UNIT**

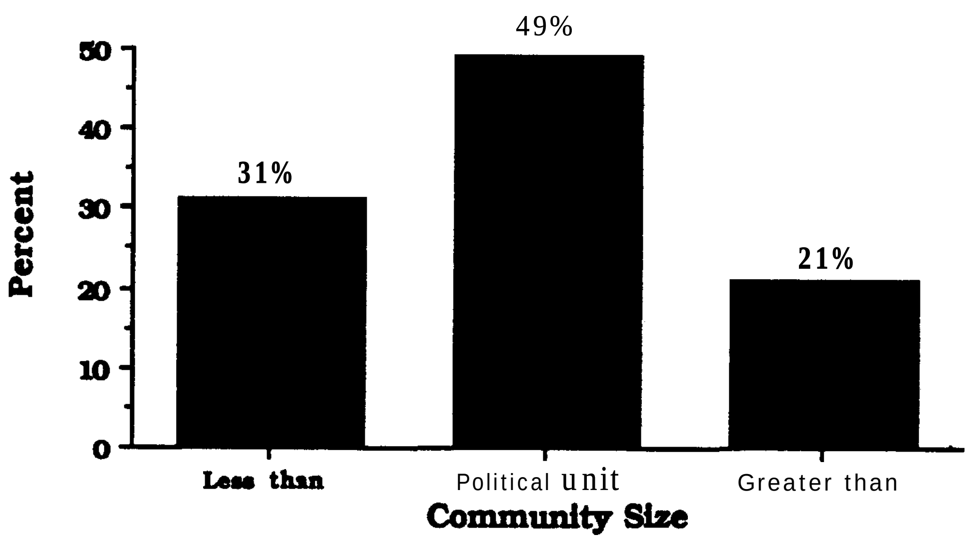
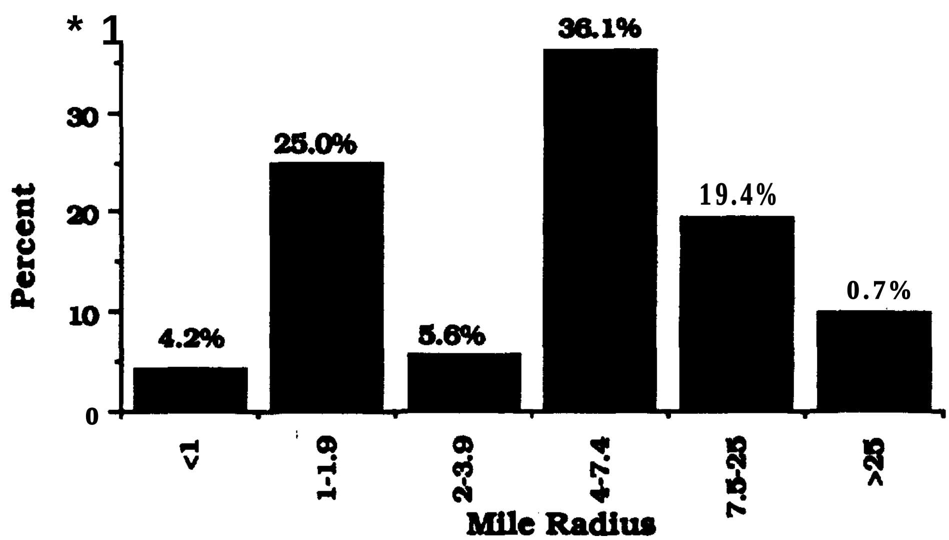


Figure 6 shows a distance measure of community. The bimodal distribution results from a lower mode consistent with the concept of a "neighborhood" (1 to 1.9 miles radius) and the upper mode consists of households who primarily view their community as consisting of their smallest local political unit *(4* to *7.4 miles* radius). Note that since post-testing was conducted in Denver, the smallest political unit is generally larger than those that exist in the Eastern portions of the U.S. where townships and/or boroughs often consist of smaller areas.

FIGURE 6: COMMUNITY SIZE AS FUNCTION OF RADIUS OF COMMUNITY



3D. Estimation of National Benefits

Industrial Economics, Incorporated (IEc) has used the results from the McClelland et al. study to calculate non-use benefits of the RCRA corrective action rule. This process involved several steps including:

- estimate individual's total WTP based on site characteristics at relevant sites
- estimate non-use values based on the individual total WTP using the extrapolation approach
- calculate the present value of the monthly willingness to pay (over ten years as in McClelland et al.) using an annual discount rate of 4 percent

- aggregate individual values across the number of households in the place where the site is located
- calculate a national benefit estimate for non-use values from groundwater cleanup using sample multipliers
- conduct a **sensitivity** analysis with respect to assumptions including: 1) population demographics, 2) size **of** contaminate-on plume, 3) dependence on: **groundwater,** 4) **contamination scenario,** 5) , effectiveness of the remedy, 6) non-response biases, 7) the extent of market and 8) the number of sites where non-use benefits apply.

Using the most reasonable assumptions (using only sites where **remediation** achieves drinkable water, only sites with off-site groundwater contamination, counting benefits as accruing when **remediation** is complete, using the extrapolation approach of McClelland et al.), IEc estimated **non-**use benefits from groundwater cleanup as a **function** of community size as shown in Table 8. **The** base estimate derived by IEc is $276 million (1992 dollars) using a market size of "place of residence." From the survey **post-**testing, the average place of residence size that appears appropriate for use in aggregating across the individuals community is slightly less than a 5 km radius.

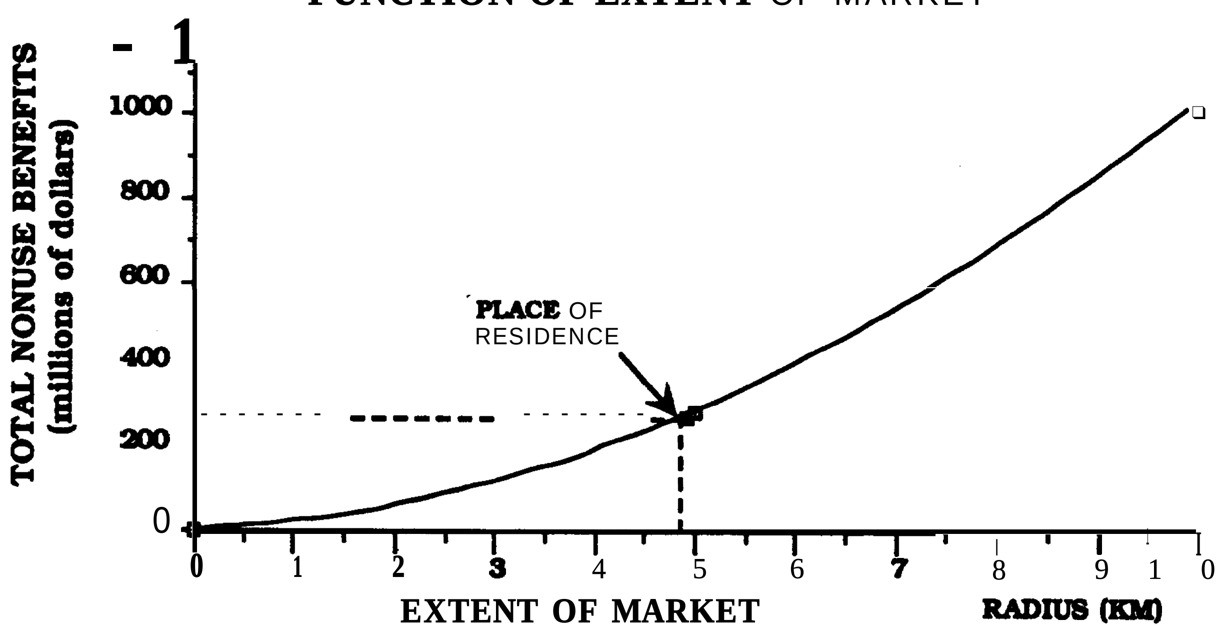
TABLE 8: TOTAL NONUSE VALUE BENEFITS FROM COMPLETE **GROUNDWATER CLEANUP AS A FUNCTION OF MARKET SIZE**

MARKET SIZE	TOTAL NONUSE BENEFITS (millions of 1992 dollars)
PLACE OF RESIDENCE	**276**
5 KM	**283**
10 KM	1,012

Assuming a zero value when the market radius is zero we can graph total non-use values as a **function** of market size in terms of kilometers radius. Thus Figure 7 graphs total non-use benefits as a function of the extent of market (in kilometers radius) and demonstrate the sensitivity of the analysis to market size. Further sensitivity analysis shows that the total national estimate ranges from $134 million to $5,559 million. The $134 million is derived **using** lower bound assumptions (non-respondents value equals zero, only counting sites with offsite well contamination, households within 5 km, benefits accruing only when **remediation** is complete). Using all upper bound assumptions (10 km radius extent of market, benefits accruing during remediation, non-respondents having a **WTP** equal to 1 /2 of respondents and including sites without offsite contamination) leads to the $5,559 estimate.

FIGURE 7:

TOTAL NONUSE BENEFITS AS A **FUNCTION OF EXTENT** OF MARKET



3E. Order of Magnitude for Benefits and Costs

Using place of residence as the best estimate of community size we obtain a total non-use benefit estimate of $276 **million.** How accurate does such an estimate have to be to be useful for policy purposes? Consider the following case: Total program costs are believed to be two hundred million dollars. Since the benefit estimate of $276 million is sensitive to a variety of assumptions about market size, treatment of non-respondents, and other factors, serious questions might arise as to whether or not benefits cover costs. On the other hand if costs are reliably estimated to be ten billion dollars, then costs are very likely to exceed benefits (at least from non-use values). The necessary precision of the benefit estimate in this case needs only to be within an order of magnitude.

4. **Conclusion**

We would like to thank the committee for the opportunity you have given us to consider your thoughtful and provocative questions. Investigators in the policy arena are only rarely given a chance to carefully reevaluate their own research.

Table 9 summarizes the empirical results of the four approaches for estimating non-use values used in the national mail survey and post-testing of the survey instrument. Each of these approaches for estimating non-use values for groundwater cleanup derive from different cognitive tasks. While we feel each of these approaches include existence values they likely include varying degrees of bequest value. Altruistic values are excluded from all of these methods. For comparison across methods, non-use values range from a low of 3696 to a high of 50% of total value for complete groundwater cleanup.

As to the question the research was asked to answer "Do non-use values exist for grouridwater cleanup?" we believe (in spite of our own initial skepticism) that they do. As to the related question of the magnitude of

TABLE 9 COMPARISON OF DIFFERENT APPROACHES TO ESTIMATING NON-USE VALUES METHOD (PREDICTED **VALUES**)[11]

	MEAN NON-USE VALUE **(STD DEV)** **n**	NON-USE VALUE AS PERCENT OF TOTAL **VALUE**
PERCENT SPLITS	**3.49** *(3.97)* 1126	**49.8%**
SCENARIO DIFFERENCES	2.81 (3.11) 345-	41.1%)
EXTRAPOLATION (QUADRATIC)	**3.54** (5.86) 344	**49.2%**
(LINEAR)	**2.79** **(4.60)** 355	**38.8%**
TEMPO-VALUATION	2.33 (5.61) 68	36.3%

non-use values, we conclude that a substantial portion of total value for groundwater cleanup at NIMBY sites derives from non-use motives since each of the four methods we have employed to attempt to partition total value yields substantial non-use value. It should be stressed that it is unlikely that people who do not know of the existence of contaminated water could plausibly hold non-use values. However, since each of these four methods for partitioning values is inherently imperfect, we do not feel that we have achieved great precision in this allocation of values. In our view, the need for precision depends greatly on the relative magnitude of benefits and costs.

[11]To adjust the temporal valuation from the post-test values to predicted values as used in the other non-use value estimation approaches, reduced willingness to pay was adjusted by the percent that willingness to pay decreased in using the Box-Cox transformation to generate predicted values in the national mail survey. The percent of total value is calculated as the mean non-use value divided by the mean total value for each of the four subgroups used in the different approaches.

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6. Appendices

6A. POST-TEST QUESTION ON TEMPORAL ASPECTS OF VALUATION

Q19. **Each site requires different levels and types of cleanup technology. Some sites will be cleaned up quickly while others may takes years to clean up due to different types of contaminants and varying soil and water conditions. When you indicated how much you are willing to pay for cleanup, how long did you expect the cleanup to take?**

Q20 **Of the dollar amount you stated you are willing to pay on your monthly water bill for the next tens years for complete cleanup, what percent would you be willing to pay if you were now informed that cleanup would be <u>completed</u> ten (1 O) years from now?**

O% 5% 10% 20% 25% 30% 40% 60% 60% 70% 75% 60% 90% 100% 125% 150% 200% 250%+

NONE — ONE FOURTH As MUCH — HALF AS MUCH — THREE FOURTHS AS MUCH — PAY THE SAME — ONE AND A HALF TIMES AS MUCH — MORE THAN TWO AND A HALF TIMES AS MUCH

Q20 **"...cleanup would be <u>completed</u> thirty (30) years from now?"**

Q21 **"...cleanup would be <u>completed</u> one hundred (100) years from now?"**

6B. VIEWGRAPHS USED IN PRESENTATION TO THE COMMITTEE BY PROFESSOR WILLIAM D. SCHULZE

OUTLINE OF RESPONSE

1) MISSION

2) COMMODITY, CONTEXT,
INFORMATION, DESIGN AND
THEORETICAL QUESTIONS

3) MARKET SIZE

4) DATA ANALYSIS

MISSION

Question:

Do any non-use benefits derive from corrective actions regarding groundwater “ contamination? If so, how large might they be?

Prior studies of air quality undertaken to satisfy OMB concerns:

- **Denver Brown Cloud: 8 survey design variants**
- **East Coast Visibility: 2 survey design variants**
- **Familiar vs. Exotic Commodity**

TABLE I

SUMMARY OF BROWN CLOUD SURVEY DESIGN FEATURES

		BASE		THREE		VOTING	FREQ. DIST.	3 COMMODITY COMPARISON	
	VERSION	A	B	C	D	E	F	G (WTP)	H (Choice)
RESPONSE FRAME	WTP	X	X	X	X	x	x	X	
	WTA	X	X			x			
HEALTH vs. VISIBILITY	3 Questions			X	X				
	% Split	X	X						
FORM OF THE VALUE QUESTIONS	Std. CVM	X	X	X	X		x	X	
	Voting					x			
	Choice								x
DESCRIPTION OF CHANGE IN AIR QULAITY	Average Air Quality Change	X	X	X	X	x		X	
	Freq. Distribution of Air Qual. Change						x		
CONTEXT/ INFORMATION CONTENT	Health Information		x		X				
	Extra Context					x			
	Minimal Context	X		X			x	X	X

CONCLUSIONS FROM PREVIOUS STUDIES

For a familiar commodity:

- **Voting context had no effect on values**
- **Information had little effect on total values**
- **Embedding disaggretation problems are serious**

COMMODITY: Non-use values for groundwater cleanup

- Prior pretesting effort by Mitchell and Carson (1989) showed this to be a very difficult commodity. They found:

  1) People know little about groundwater

  2) People rejected an existence value scenario where groundwater would never be used

- Groundwater cleanup provided a perfect commodity to test the methodological limits of contingent valuation

- Complete intellectual freedom provided by OSW and OPPE

- Limited budget for study

COMMODITY DEFINITION

- USEPA wanted benefits of complete groundwater cleanup

- Containment was proposed as a backup technology where complete cleanup was technologically impossible

- Complete cleanup provides a vector of services:

  (1) In s o m e cases it provides clean water for use by the present generation (use and altruistic value)

  (2) Clean water for use by future generations (bequest value)

  (3) Knowledge that "mother earth" is not contaminated (existence value or moral value)

- Disaggregation of such values has proven difficult.

UNDER WHAT CIRCUMSTANCES MIGHT NON-USE VALUES ACTUALLY EXIST?

- **Contrast (1) Expert Benefits with (2) Subjective Benefits**

  (1) Expert Benefits are defined as the benefits experts believe to exist (e.g. Value of Life X Expert Assessment of Risk Reduction X Exposed Population). This measure excludes non-use values.

  (2) Subjective Benefits are defined as the values potentially exposed populations themselves place on environmental cleanup. These will be based on perceived risks and may include non-use values.

- **Consumer Sovereignty vs. Expert Assessments**

- **To obtain non-use values one must measure subjective values.**

SUBJECTIVE VALUES

- **Substantial subjective values have been shown to exist for NIMBY sites in a large number of studies using property values and/or contingent values where expert risks are very small**

(1) V.K. Smith and W.H. Desvousges "The Value of Avoiding a LULU: Hazardous Waste Disposal Sites" <u>ReStat</u> 1986.

(2) McClelland, Schulze, Hurd, "The Effect of Risk Beliefs on Property Values: A Case Study of a Hazardous Waste Site," <u>Risk Analysis</u> 1990.

GROUNDWATER SCENARIO DEVELOPMENT

(1) Offsite groundwater contamination of wells assures public awareness

(2) Public officials have <u>never</u> knowingly allowed contaminated water from a NIMBY site into a public water supply for fear of public outrage no matter how small the expert assessment of risk

(3) Risk information in the pretest survey caused 15% of pretest subjects to raise value for cleanup, 9% to lower value and had no effect on 76%.

(4) Risk communication has been surprisingly ineffective in real world NIMBY situations

(5) Values from this study should most appropriately be applied to sites with actual or potential offsite contamination of wells.

DEFAULT ASSUMPTIONS IF COMPLETE CLEANUP IS NOT FUNDED

- **Very large values obtained in a previous contingent valuation study of groundwater (Steven Edwards, "Option Prices for Groundwater Protection," JEEM, 1988).**

- **Default Assumptions (Fischoff and Furby, 1988)**

- **People may fear no groundwater will be available for themselves or future generations (No substitutes)**

- **Specify several default alternatives (substitutes for complete cleanup of groundwater available to current and/or future generations) to eliminate fear of "no water" such as**

  1) Home treatment

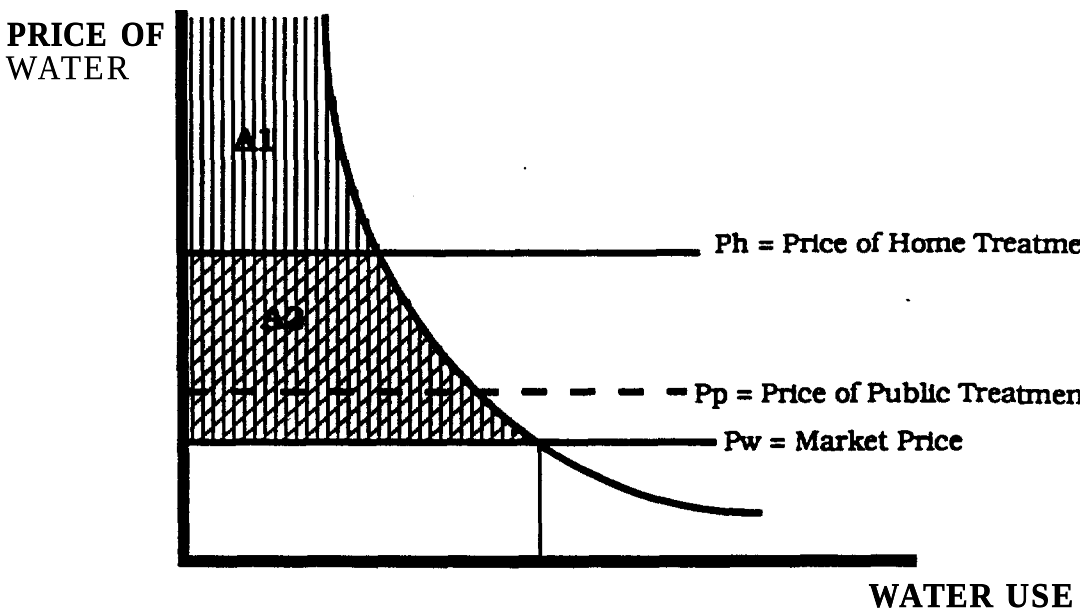
  2) Public treatment (most favored)

  3) Shortage not 10070 (surface water)

  4) Containment.

PROVISION OF SUBSTITUTE COMMODITIES

CONSIDER THE EFFECT OF SUBSTITUTES ON USE VALUE (DEMAND FOR WATER)



Al = CONSUMER SURPLUS WITHOUT A SUBSTITUTE

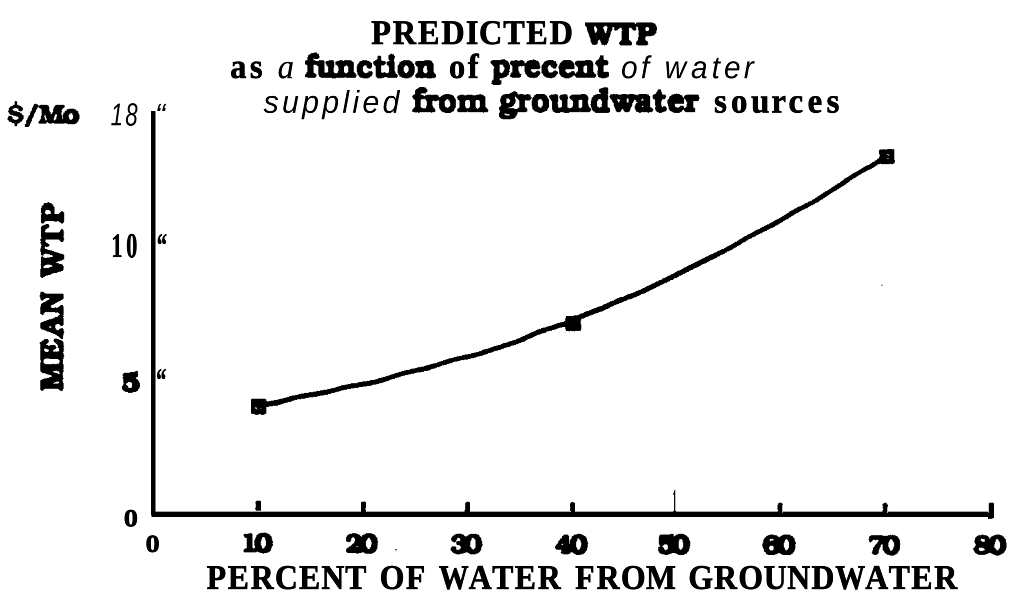
A2 = CONSUMER SURPLUS WITH A SUBSITUTE OF HOME TREATMENT

- **CONSUMER SURPLUS LOWER STILL IF Pp IS ASSUMED TO BE LESS THAN Ph**

- **ALTRUISTIC AND BEQUEST VALUES ALSO LOWERED IF RESPONDENTS ASSUME FUTURE GENERATIONS HAVE SUBSTITUTES**

IMPLIED DEMAND FOR WATER

The survey was designed so that if complete cleanup is not funded, respondents would likely assume a cheaper alternative would be funded (such as public treatment) or as a last resort, home treatment. The small value obtained for cleanup with a 70% dependence on groundwater suggests that respondents were assuming substitute alternatives were available



WHAT IF YOU DEPENDED LESS OR MORE ON GROUNDWATER

Dependency on groundwater is different for every location at which contamination has occurred. Some areas use groundwater for all of their domestic water supply while others use none. To plan new groundwater cleanup programs that could cost you money, " decision makers want to learn how much clean groundwater is worth to people like you in these different situations.

WHERE GROUNDWATER SUPPLIES 10% OF DOMESTIC WATER

Q16 Consider an imaginary leaking landfill identical to that described above except that now groundwater supplies 10*A of the domestic water supply instead of 40%. Remembering that, on average, households use half of their domestic water outdoors, one third in the bathroom and the rest in the kitchen how satisfied are you with water rationing as an option where water use would have to be cut by 10%?

NOT AT AU SATISFIED						EXTREMELY SATISFIED	
1	2	3	4	5	6	7	(3.64)

Q17 What would a complete cleanup program like that described in Q6 be worth to your household if your imaginary community faced a groundwater problem where 10% of the local domestic water supply . comes from groundwater which was contaminated and could not be used without treatment? In answering you should assume that:

- **The hypothetical situation is now one in which only 10% of the water you use in your community comes from groundwater resources. The other 90% of your water comes from surface water sources such as lakes and streams.**

- **The complete cleanup program is identical to the program described in the previous section.**

Now, of the dollar amount you would have paid just for complete groundwater cleanup when faced with 40% of your water supply contaminated, what percent would you still be willing to pay for complete groundwater cleanup if faced with 10% of your water supply coming from contaminated groundwater?

(46.51°/0)

NONE		SOME			HALF			MOST		ALL
0%	10%	20%	30%	40%	50%	600/0	70%	80%	900/0	100%

WHERE GROUNDWATER SUPPLIES 70% OF DOMESTIC WATER

Q18 **Consider an imaginary leaking landfill identical to that described above except that now groundwater supplies 70% of the domestic water supply instead of 40°/0. Remembering that, on average, households use half of their domestic water outdoors, one third in the bathroom and the rest in the kitchen how satisfied are you with water rationing as an option where water use would have to be cut by 70%?**

NOT AT ALL SATISFIED						EXTREMELY SATISFIED	
1	2	3	4	5	6	7	(2.35)

Q19 What would a complete cleanup program like that described in Q6 be worth to your household if your imaginary community faced a groundwater problem where 70% of the local domestic water supply comes from groundwater which was contaminated and could not be used without treatment? In answering you should assume that:

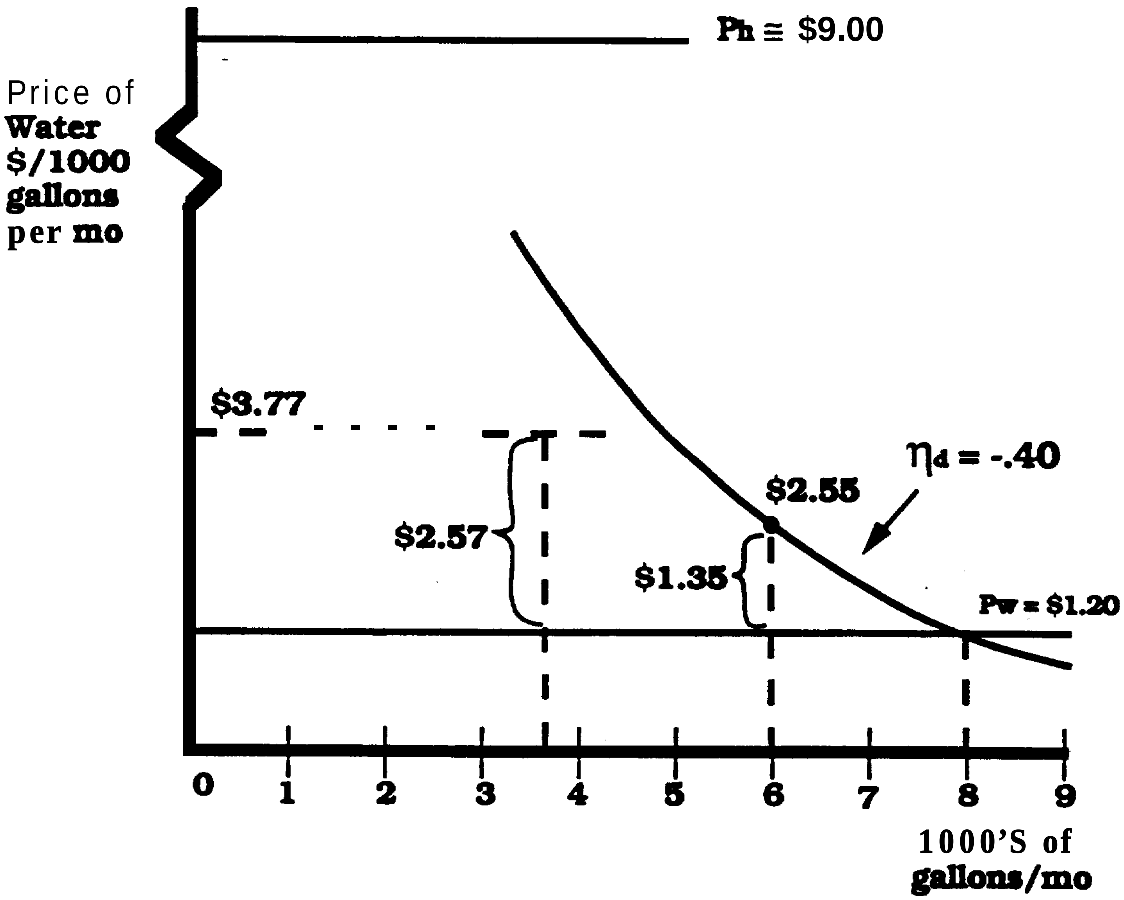
- **The hypothetical situation is now one in which 70% of the water you use in your community comes from groundwater resources. The other 30°/0 of your water comes from surface water sources such as lakes and streams.**

- **The complete cleanup program is identical to the program described in the previous section.**

Now, of the dollar amount you would have paid just for complete groundwater cleanup when faced with 40% of your water supply contaminated, what percent would you be willing to pay for complete groundwater cleanup if faced with 70% of your water supply coming from contaminated groundwater? (Circle the best per cent response)

(166.24%)

SAME				TWICE AS MUCH		3 TIMES AS MUCH		MORE THAN 4X AS MUCH
10OO/.	125%	150%	175%	200%	250%	300?40	350%	400%+



- Average household price and consumption from Michael Nieswiadomy " Estimating Residential Water Demand" <u>WRR</u> (1992)

- Range of Demand Elasticity Estimates

  -.11 Nieswiadomy (op. cit. 1992)
  -.57 Howe <u>W R R</u> (1982)

IMPACT OF INFORMATION/CONTEXT

- Mean household value fell from $20.22 to $12.20 per month
- Small samples, n≈ 40 each
- Debriefings used to explain value decrease (Table 4.2)
- Conclusion: Information on substitutes lowered values
- Emphasized substitutes in final survey design
- Conservative choices

TABLE *4.2* **SELF-REPORTED EFFECTS OF CONTEXT - DECEMBER** 1990

PRETEST

Self-reported Effects of Context from December 1990-Retest (Summary of responses to Q-47 through Q-56, Appendix B)

	Percentage				
Self-reported effect	9-47 Pers. **exp.**	**Q-48** Def. of gwater.	**Q-49** Speed of gwater.	**Q-50** Water bill	**Q-51** Buy water option
No effect	**75%**	**82%**	**90%**	**77%**	**67%**
Lowered value	**0%**	3 **%**	**8%**	**8%**	20%
Raised value	**25%**	15%	2 **%**	**15%**	13%

	Percentage				
Self-reported effect	9-62 Water cons.	Q-53 Private options	**Q-54** **Dis-**counting	**Q-55** W. S. T. option	**Q-56** Risk **commun.**
No effect	**72%**	**66%**	**79%**	**61%**	7 6 %
Lowered value	**13%**	24%	10.5?40	**34%**	9 **%**
Raised value	**15%**	11?40	10.5%	5 **%**	15?40

VALUE PARTITIONING

(1) Theoretical Issues (% splits)

- Separable Utility Function
- Constant Marginal Utility of Money

(2) Psychological Issues

- Do people have enough information to partition
- Have people thought carefully enough about issues to allow partitioning

PORTIONING:
THEORETICAL ISSUES

C_1 = Consumption by generation 1

W_1 = water consumption by generation 1

Z = amount of contaminated groundwater

U^2 = utility of next generation or others

Separable Utility Function:

(1) $U^1(C_1, W_1, Z, U^2) = V(C_1) + F(W_1) - D(Z) + A(U^2)$

Willingness to pay for complete cleanup (WTP) which provides $\Delta W_1 > 0$, $\Delta Z < 0$ and $\Delta U^2 > 0$ is determined by:

$$(2)\quad U^1(C_1 - WTP, W_1 + AW, Z + AZ, U^2 + \Delta U^2) = U^1(C_1, W_1, Z, U^2) \quad \text{or}$$

$$(3)\quad -\Delta V = \Delta F - \Delta D + \Delta A$$

- **With constant marginal utility of money (consumption) i.e., $\partial V/\partial C_1 =$ constant:**

$$(4)\quad WTp = \left(\frac{AF}{\partial V/\partial C_1}\right) + \left(\frac{\_\_}{\partial V/\partial C_1}\right) + \left(\frac{\Delta A}{\partial V/\partial C_1}\right)$$

Use Value	Existence Value	Bequest or Altruistic Value

- **Constant marginal utility of money is plausible since estimates of total WTP are about 1/4 of 1 % of income**

- **Separability is an empirical question but non-use values are usually assumed to be separable which makes market based measurement impossible (M.A. Freeman, "Non-Use Values in Natural Resource Damage Assessment" <u>Natural Resources Damages: Law and Economics.</u> 1992)**

PARTITIONING

PSYCHOLOGICAL ISSUES

- Pretest respondents rejected fund for future use
- Also had rejected existence value scenario
- Alternative scenarios used to educate respondents and get them to think about future generations, others' and existence value.

Option(Rating)	Benefits
Complete Cleanup (4.35)	Respondents' Use, Others' Use, Future Use, Protection of Earth
Containment (3.45)	Same as above but less certain
Public Treatment (3.74)	Respondents' Use, Others' Use
Home Treatment (2.81)	Respondents' Use

COMPONENT ALLOCATION OF TOTAL WILLINGNESS TO PAY FOR COMPLETE GROUNDWATER CLEANUP (RANDOM SUBSAMPLE

OBS	USE	ALTRUIST	BEQUEST	EXISTENCE
50	0	0	0	100
100	0	0	0	100
150	25	25	25	25
200	33	33	34	0
250	20	20	30	30
300	0	50	50	0
350	30	30	30	10
400	50	20	20	10
450	0	100	0	0
500	60	20	20	0
550	50	30	10	10
600	25	25	25	25
650	90	4	4	2
700	50	20	25	5
750	25	25	25	25
800	25	25	50	0
850	25	25	25	25
900	50	0	50	0
950	100	0	0	0
1000	33	33	34	0
1050	30	30	30	10
1100	40	30	30	0
1150	25	25	25	25
1200	0	0	100	0
1250	30	30	30	10
1300	0	0	0	100
1350	30	10	10	50
1400	33	33	34	0
1450	25	25	25	25
1500	25	25	25	25
1550	58	22	3	17
1600	70	5	20	5
1650	25	25	25	25
1700	0	0	0	100
1750	0	0	0	100
1800	50	20	20	10
1850	20	20	30	30
1900	60	30	5	5
1950	33	33	34	0
2000	0	0	0	100

OTHER DESIGN ISSUES

- Did not ask for water bill

  1) Small positive impact in self-reported effect of context on values (Table 4.2)

  2) Many people didn't know the answer

- Did not allow " don't know" as a response

  1) Little data is available to support one position or another

  2) DK response provides an easy out to difficult questions

  3) Creates econometric problems by encouraging missing observations

  4) Failure to include DK may encourage "bad answers"

  5) Need testing.

.. DESIGN ISSUES (CONT.)

- **Payment card**

  1) **Used approximate geometrically increasing values where upper limit is chosen not to truncate values**

  2) **Rowe et al. study (1993) using payment card values of the form $(1+X)^n$ for $n = 0, 1, \ldots, N$ values shows no effect of varying X unless the Nth value (last value) truncates rhs of value distribution.**

DESIGN ISSUES (CONT.)

. Referendum with dichotomous choice vs. payment card

1) Brown Cloud study showed no impact of referendum context alone (open ended value question)

2) Values very similar in preliminary pretest and final pretest of groundwater survey.

3) Need more research but doubt large differences will be found between payment card and dichotomous choice because they are similar cognitive tasks. However, surprises are not uncommon.

4) We know of no data based evidence to pick one approach over the other.

6C. VIEWGRAPHS USED IN PRESENTATION TO THE COMMITTEE BY PROFESSOR GARY H. MCCLELLAND

Resolution of Statistical Issues

- Interdisciplinary confusions about mathematically equivalent terms and procedures

- Draft report for a different audience

- Appropriate Level of Precision

  — Sensitivity Analysis

  — Policy context, comparison to costs

Oversampling of NPL Households

- EXPOSED dummy variable not significant in original analysis

- Test of Equality for Separate Regressions: F(I 5,1 967)=0.96

- Search for any pairwise differences on any variables

Exposed vs Non-Exposed Differences

— Demographically similar
INCOME, KIDS, AGE, EDUC, GENDER
no sign. cliffs
marginally more WHITE

— USE, more likely to use groundwater or be aware of it

— SOURCES, more aware of sources of local gwater contamination

— RECYCLES, more likely to be a recycler
??

— COMPLETE, MEANNCOM, & RESPONS are lower in exposed. (attitude change as a function of experience?)

— Predicted WTP
Exposed: $7.77 Non-Exposed: $6.90
n.s.

RESPONS

Responsibility Variable

- Strong predictor of WTP
  (t= 1 8.6)

- Exogenous or Endogenous

- Not available for policy

Sensitivity to its omission

Omitting RESPONS
(Box-Cox)

- λ: .15 to .13

- R^2: .30 to .18

- Other variables:
  - — OTHENV no longer sign.
  - — MEANNCOM now sign.
  - — no sign changes

- Predicted WTP: $7.01 to $6.48

- RESPONS quadratic effect

Box-Cox Estimation

$$WTP' = \frac{WTP^{\lambda} - 1}{\lambda} \quad \text{if } \lambda \neq 0$$

$$= \log(y) \qquad \text{if } \lambda = 0$$

- Handling WTP=0
  - — including implies $\lambda > 0$
  - — prior empirical results and theory suggested $\lambda \leq 0$
  - — so replaced WTP=0 with WTP = ε
  - — examine sensitivity to choice of ε
- Variability of estimate of λ

FIGURE 6.6 REDUCED WTP FOR COMPLETE GROUNDWATER CLEANUP
NATTONAL MAIL SURVEY

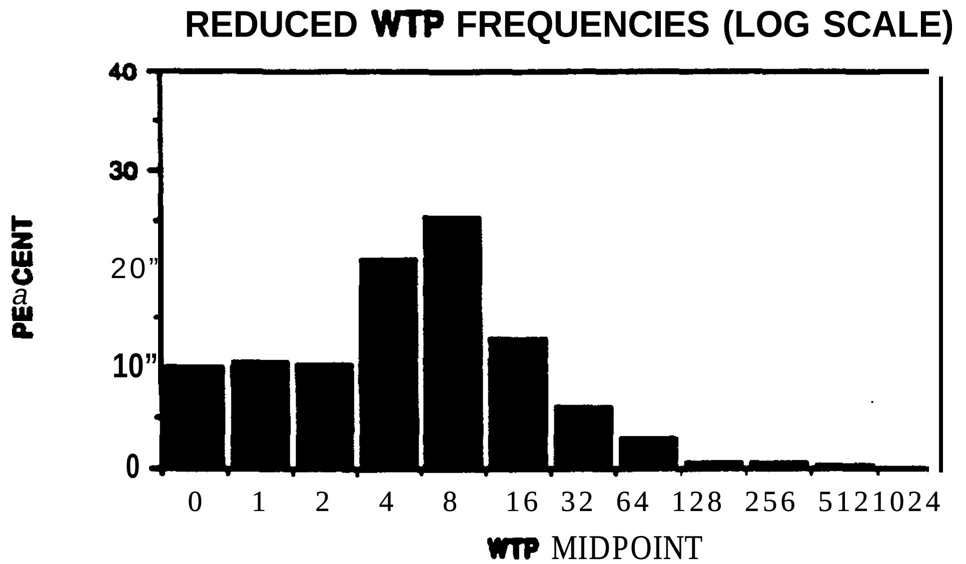
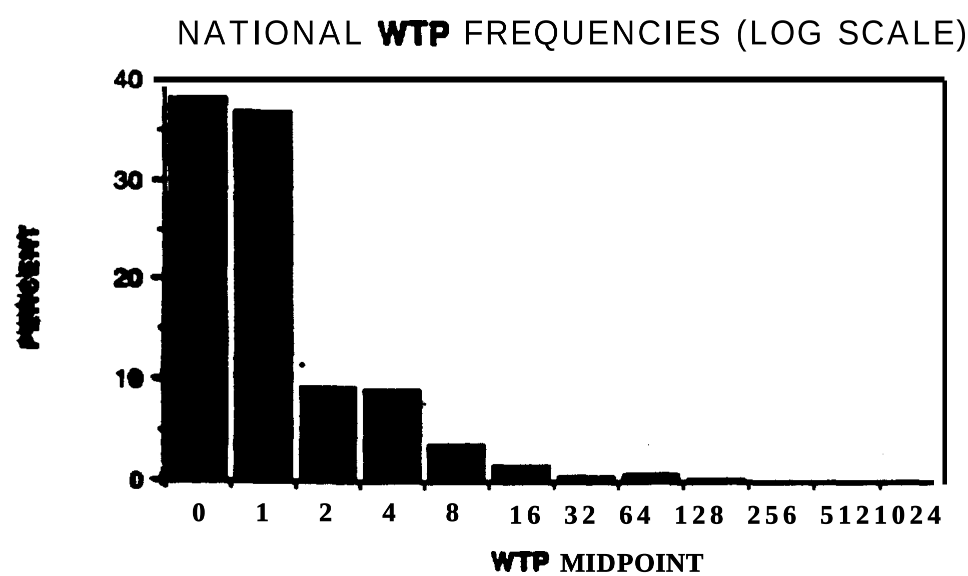


FIGURE 6.9: WTP FOR NATIONAL CLEANUP PROGRAM
NATIONAL MAIL SURVEY



Box-Cox Sensitivity

Zero set to	Mean WTP	Gee. Mean	λ [95%C.I.]	Pred. Mean WTP	Income Coef.
10$	11.711	4.49	0.15 [.125,.165]	7.01	3.07
1¢	11.704	3.71	0.21 [.195,.235]	7.15	2.99
.1¢	11.703	3.07	0.24 [.225,.255]	7.23	2.99

TABLE 7.7: LINEAR REGRESSION ON **BOX-COX TRANSFORMATION** OF **REDWTP** (a = **0.15)**

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Modal	2S	290 S1.93129	1162.0772S	34.272	0.0001
Error	1957	663 S7. S1024	33.90777		
C Total	1982	9S409.44153			

Root MSE	5.82304	R-square	0.3045
Dep Mean	6.90664	Adj R-sq	0.2956
C.V.	84.31072		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for HO: Parameter=0	Prob > !T!
INTERCEP	1	-5.832276	1.4531s9s7	-4.014	0.0001
INCOMEVD	1	0.026445	0.00432236	6.118	0.0001
KIDS	1	0.016927	0.31086890	0.054	0.9566
AGE	1	-0.040563	0.01002827	-4.04s	0.0001
WHITE	1	0.776703	0.4S832938	1.69S	0.0903
EDuc	1	0.382S80	0.0808S742	4.732	0.0001
GENDER	1	0.100170	0.29853243	0.336	0.7373
NORTHEAS	1	-0.3S2492	0.7s477114	-0.467	0.640S
NEWYORK	1	0.938023	0.68434316	1.371	0.1706
MIDATLAN	1	0.4S3276	0.666910S9	0.680	0.4968
SOUTH	1	-1.129931	0.63122688	-1.790	0.0736
LAKES	1	0.151642	0.6079S37S	0.249	0.8031
SOUTHWES	'	-0.706929	0.682S2417	-1.036	0.3004
MOUNTAIN	1	0.3208S1	0.824743SS	0.389	0.6973
WEST	?	-0.195098	0.71671498	-0.272	0.7855
NORTHWES		-0.043883	0.81344447	-0.054	0.9570
LANDFILL		-0.S4S102	0.32416310	-1.682	0.0928
EXPOSED	1	-0.229842	0.22S302S8	-1.020	0.3078
USE	*	0.8S0450	0.27S83740	3.083	0.0021
SOURCES	?	0.424435	0.12S82177 ,	3.373	0.0008
RECYCLES	:	0.08S447	0.06S23121	1.310	0.1904
OTHENV	1	-0.606282	0.17686973	-3.428	0.0006
GRNDWTR	1	0.469827	0.13647S64	3.443	0.0006
COMPLETE	1	0.35824S	0.077S2901	4.621	0.0001
MEANNCOM	1	0.223914	0.12073641	1.8SS	0.0638
RESPONS	1	1.S92300	0.08s80801	18.557	0.0001

Variable	Label	N	Mean	Std Dev
REDWTP	reduced wtp	231S	11.5783S85	2S.9979281
PREDWTP	pred in dollars	1983	7.0077342	5.2925489

FIGURE 1:

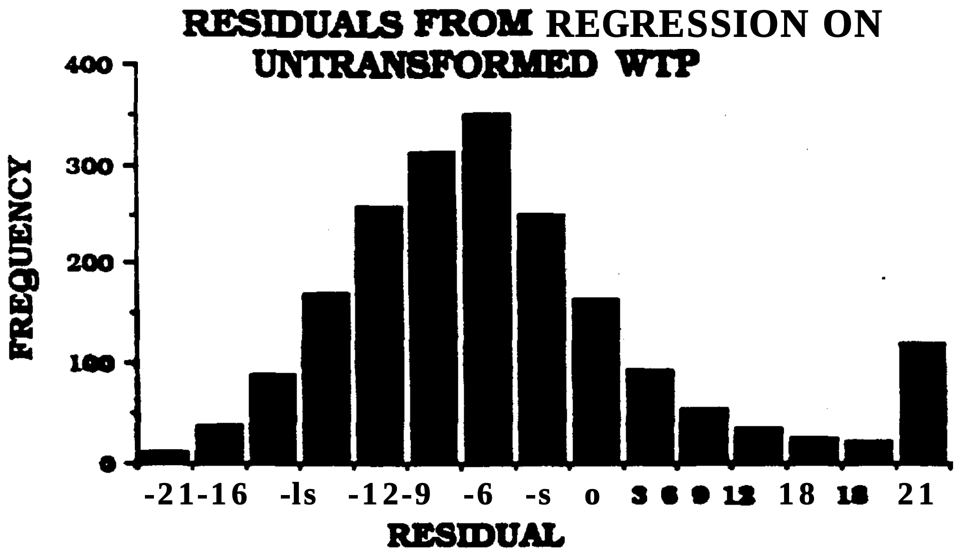
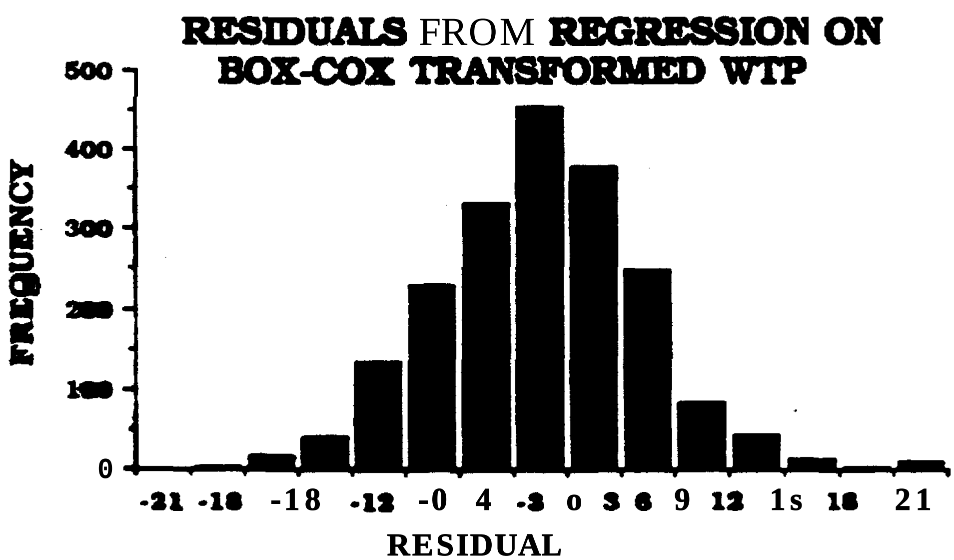


FIGURE 2:



Version D
(1 O%, 40%, 70% Shortages)

- Separate analysis for this group?

  — Yes, and it made no difference on percent splits

. Correlated errors from multiple responses

$$WTP = \beta_0 + \beta_1(\%Short) + \beta_2(\%Short)^2 + \varepsilon_i$$

Estimated β_0 for each person

3 eqns and 3 unknowns for each person

Solves correlated error problem

TABLE 7.21: COMPARISON OF DIFFERENT APPROACHES TO ESTIMATING NON-USE VALUES (for predicted values)

METHOD	BEQUEST PLUS EXISTENCE	STANDARD DEVIATION	N
PERCENT SPLITS	3.49	3.97	1126
SCENARIO DIFFERENCES	2.81	3.11	345
EXTRAPOLATION	3.54	5.86	344

Estimate Reliability within Respondent

- $\hat{\beta}_0$ vs. %splits

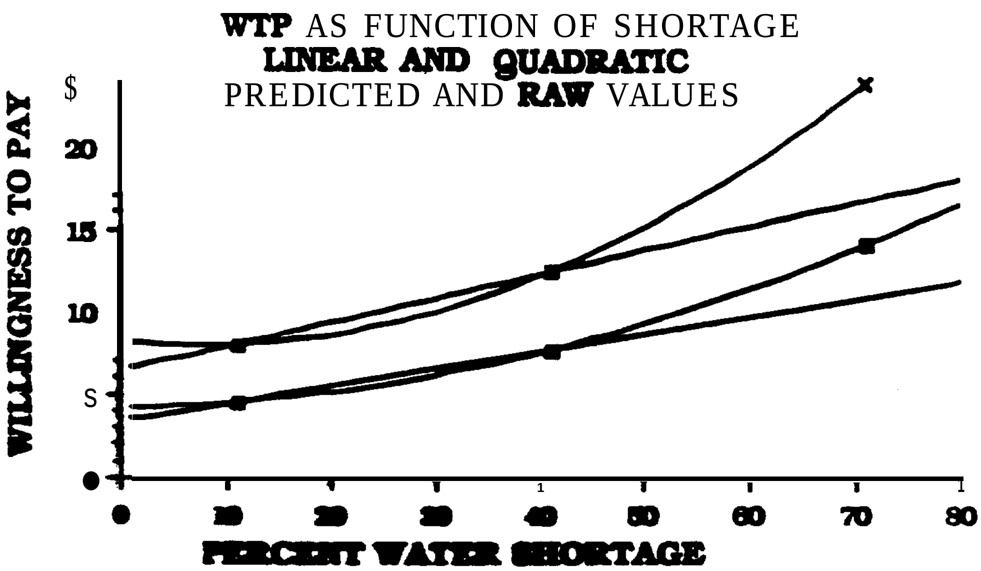
  Mean cliff = $.08
  n = 354
  t = 0.78 n.s.

- Scenario Diff vs. %splits

  Mean cliff = $-1.62
  n = 337
  t = -2.93 $p < .005$

  — public treatment option may contain bequest value

  — therefore, scenario difference may underestimate non-use value



COMPARISON OF DIFFERENT APPROACHES TO ESTIMATING NON-USE VALUES (FOR PREDICTED VALUES)

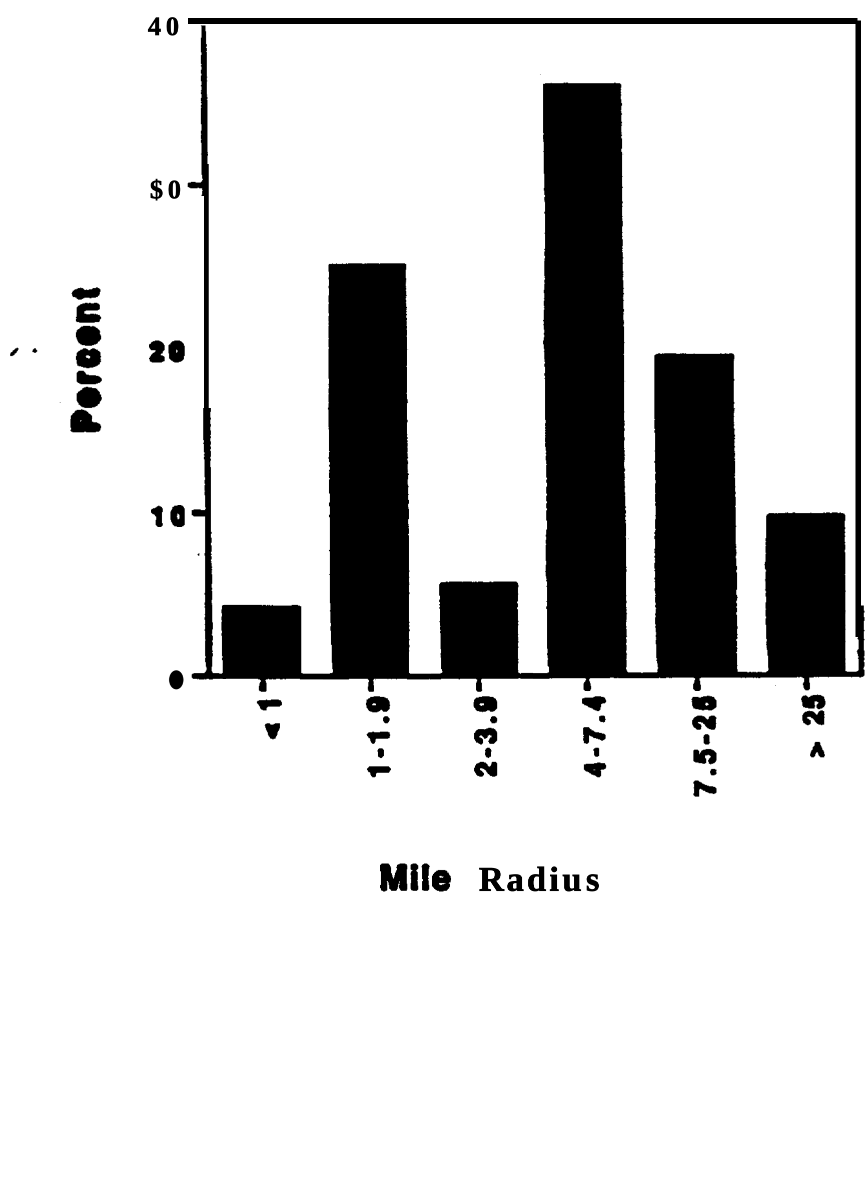
METHOD	MEAN ESTIMATED NON-USE VALUE	STANDARD DEVIATION	n
PERCENT SPLITS	3.94	3.97	1126
SCENARIO DIFFERENCES	2.81	3.11	345
EXTRAPOLATION (QUADRATIC)	3.54	5.86	344
EXTRAPOLATION (LINEAR)	2.89	4.64	344

YOUR COMMUNITY

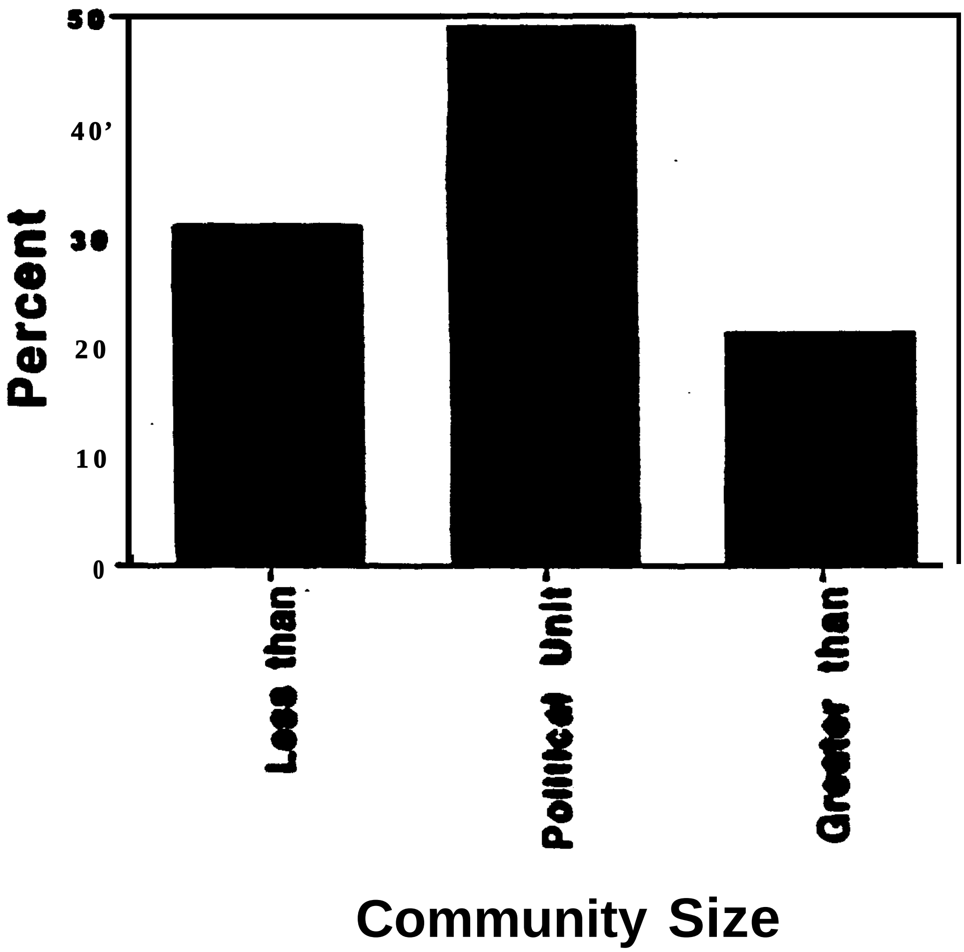
Q1 8 **Different** people have different ideas about **the size of their community. Among the different descriptions of the size of a community** that are **listed below, please circle the letter next to the one that most closely describes what you think of as defining the size of your own community.**

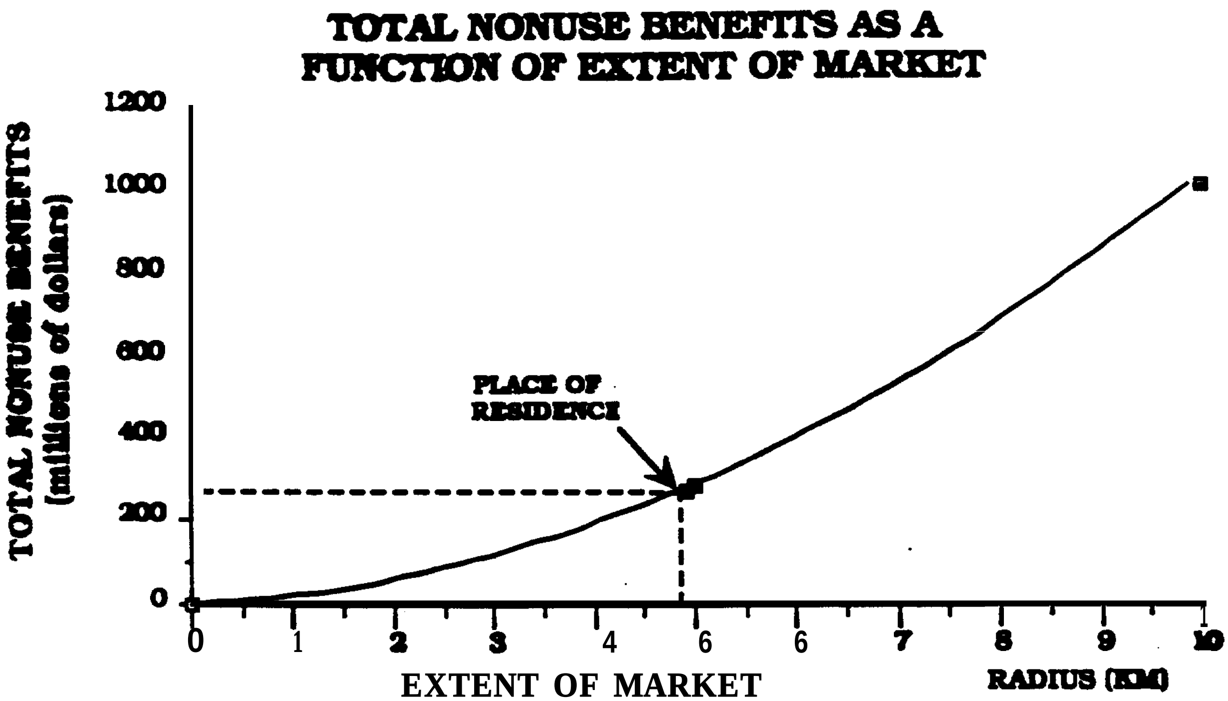
A. Just my block.
B. Just my block and the next two blocks in any direction.
C. The area that I could drive from my house to the edge of in five minutes in city traffic (not at rush hour).
D. The area that I could drive from my house to the edge of in fifteen minutes in city traffic (not at rush hour).
E The area that I could drive from my house to the edge of in thirty minutes in city traffic (not at rush hour).
F. The entire city in which I live
G The entire county in which I live
H. The entire state of Colorado.
I. The entire nation.
J. Other. Please describe ________________

Community Size Definitions
for Groundwater WTP



Community Size Definitions for Groundwater WTP





MARKET SIZE	TOTAL NONUSE BENEFITS (millions of 1992 dollars)
PLACE OF RESIDENCE	276
5 KM	283
10 KM	1,012